Occupying Time
Design, technology, and the form of interaction
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Abstract

As technology pervades our everyday life and material culture, new possibilities and problematics are raised for design. Attention in contemporary design discourse is shifting 'beyond the object', to the qualities of processes and experiences. The boxes and screens typically the 'object' of interaction and interface design are miniaturizing, even disappearing, as computation is integrated into familiar materials and ordinary objects. This opens possibilities – for example, as computer and materials science converge with fashion and architecture in smart textiles and intelligent environments – even as it turns us back, in new ways, to traditional design disciplines and practices.

In this context, design is not only about the spatial or physical form of objects, but the form of interactions that take place – and occupy time – in people's relations with and through computational and interactive objects. As argued in this thesis, a central, and particular, concern of interaction design must therefore be the 'temporal form' of such objects and the 'form of interaction' as they are used over time. Furthermore, increasingly pervasive technology means that the temporality of form and interaction is implicated in more widespread changes to the material conditions of design and of society. Challenging conventions – of 'formalism' and 'functionalism', 'good' and 'total' design – temporal concerns and implications require new ways of thinking about and working with the materiality, users, and effects of design.

Located at an intersection between emerging technologies and design traditions, interaction design is approached in 'Occupying Time' through diverse disciplinary frames and scales of consideration. If focus in interaction design is typically on proximate 'Use', here a discussion of 'Materials' scales down to reconsider the more basic spatial and temporal composition of form, and 'Change' scales up to large-scale and long-term design effects. To anchor these themes in existing discourse and practice, architecture is a primary frame of reference throughout to explore certain problematics. Accounts of 'event', 'vernacular', and 'non-design', and concepts of 'becoming', 'in the making', and 'futurity', thus extend a theoretical and practical basis for treating time in (interaction) design discourse.

Implications for practice also emerge and are discusssed. Basic to the materiality of interaction design, technology puts time central to 'Material practice'. 'Participatory practice' moves beyond user involvement in design processes to participation in ongoing formation. Since temporal form extends design more deeply and further into future use, 'Critical practice' examines effects and responsibility. More specific and concrete reflections are situated in relation to my experience in the design research programs 'IT+Textiles', 'Public Play Spaces', and 'Static!'. Drawing from architectural discourse and from my own practice, this thesis maps out and builds up a territory of ideas, relations, and examples as an inquiry into issues of time in interaction design.

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Introduction

Occupying time

Perhaps it comes as no surprise that technology occupies time. Time passes as we navigate, scroll, and select among options, download, read, and wait for information through the limited 'screen real-estate' and bandwidth of mobile phones, PDAs, and laptops. No sooner have we customized preferences in our computer's operating system or incorporated input sequences on our phones into subconscious habit, than software updates or new products are released. Rapid technical advances and designed obsolescence effect a rapid turnover of the devices and systems pervading our offices and streets, living rooms and pockets. Introduced into modern popular culture with proclamations of the 'annihilation of space through time', technology continues to reconfigure the space – and time – of our everyday lives and lifestyles.

Indeed, so-called 'post-industrial' technologies have been described as part of a trend toward increasing immateriality, toward dematerialization of the primarily spatial forms long central to thinking and making in design. As information and communication technologies become more pervasive in everyday life, attention in contemporary discourse is shifting 'beyond the object', to processes rather than products, and the design of systems, services, and experiences. Indeed, such technologies are particularly, even primarily, temporal in nature – computer programs are executed sequentially, over time, even as interactivity entails that users may interrupt and change computational processes along the way. Thus, computation and interactivity shift attention from spatial form in itself to the form of interactions that take place – and occupy time – in our everyday relations with and through technological objects.

Time is thus central to designing such interactions. Indeed, in the field of interaction design, we are accustomed to crafting flows and sequences of such interaction. As means for giving form to abstract information, remote services, and ongoing experiences, graphical and tangible interfaces have long been in focus. However, the boxes and screens housing and representing technologies – typically the 'object' of interface and interaction design – are rapidly miniaturizing, multiplying, and even disappearing. With shrinking hardware and embedded technologies, the 'disappearing computer' is increasingly integrated into ordinary objects and familiar materials that become 'sensitive', 'smart', and 'fast'. As interaction design must develop beyond the (dis)appearance of interfaces to interactive systems and user experiences, so must our conception of the materiality, forms, and effects of interaction.

Forms of interaction with technologies take place, and occupy time, at a variety of scales in everyday life. Beyond mere 'use', living with technologies involves processes of interpretation, incorporation, and appropriation into intimate lifeworlds. In addition to the technological time of computation and interactivity, concern for such aspects resonates with other temporal concepts – from the value of 'patina', 'rust', and 'vintage' in material culture, the 'subjective time' and 'lived time' of psychological and phenomenal accounts, to the 'historical time' and modernist 'zeitgeist' traced through design history, and speculation on 'futures' in politics and concept design. Spatially and temporally, technologies are ever more intimately intertwined with everyday practices – in the rhythms of lived experience, patterns of social and societal interaction, and evolving cultural memory.

In light of such implications on the space – and time – of everyday life and lifestyles, this text explores and expands upon temporal concepts that become increasingly relevant as technologies becomes integrated and pervasive in many forms. Given certain existing concerns in interaction design, and influences from time-based arts and media, temporal considerations may not seem new. However, increasing integra-

tion of new technologies into the very fabric of our material life suggests the need for further consideration. For one thing, we might expand our temporal conceptions with respect to the dynamics of materials, use, and change. If focus in interaction design is typically on the scope and scale of proximate 'Use' of technological objects, in this text, additional themes of 'Materials' scale down to consider the more basic composition of form, the temporal performances of 'atoms and bits', and 'Change' scales up to consider interaction in terms of large-scale and long-term effects.

Further, we might develop such consideration in relation to established design discourse and practice. Indeed, as technologies 'disappear' into a variety of new and strangely familiar forms, we return, paradoxically, to things long the 'object' of concern in traditional design disciplines. In this text, temporal concepts are explored in relation to one of the most object-oriented – architecture. Challenging us to consider form beyond the terms of proximate use, architectural and urban forms must accommodate change in composition and in future use in order to be sustained over time. Architectural discourse and accounts of practice are thus, here, a basis for enquiry into existing and emerging temporal concepts of form and interaction in relation to im/material life, participatory culture, and societal effects. Exposing certain problematics in (interaction) design theory, issues for practice are raised and taken further in terms of 'Material practice', 'Participatory practice', and 'Critical practice'.

Thus introducing some of the context of this work that will be covered in more depth in the 'Introduction' section to follow here, this also serves to outlines the structure of this text. Themes – 'Use', 'Materials', and 'Change' – guide a discussion through a series of concepts and theories, fields and communities of practice, and projects and programs in design research. The first sections of each theme, 'Material life', 'Becoming users', and 'Design effects', explore certain theoretical perspectives on time in philosophy, architecture, and interaction design. Then, 'Material practice', 'Participatory practice', and 'Critical practice' draw out implications for practice, tracing related concerns, strategies, methods, and examples across the applied arts. Finally, 'IT+Textiles', 'Public Play Spaces', and 'Static!' orient certain questions through my personal experience within interaction design research programs.

Roughly tracing a trajectory from theoretical perspectives 'into' design from the outside to practical experiences from within and 'through' design research, temporal concepts in interaction design are approached from the top-down and from the bottom-up, with certain shared practices and issues inserted between. The three themes, and transverse divisions of theories, practices, and programs, make up a 3x3 framework evident in the organization of the table of contents – a form that has also been the ordering principle for the writing process. As such, this text maps out and builds up a view of interaction design within an expanded – and rapidly expanding – field of relations between technology and design.

Technology and design context

Technology pervades our everyday lives. Every day, we encounter any number of electric, mechanical, electronic, and digital artifacts. Computers used to be rare and costly, taking up entire rooms in research labs. Then, desktop versions became more generally available, then laptops and handhelds for personal and mobile use. By now, the boxes and screens we have come to associate with computaters are diversifying into any number of forms. Technological objects populate our kitchens and cars, bedrooms and pockets. Miniaturized components, pervasive wireless, and smart materials facilitate embedded systems that are context-aware, personalized, and adaptive. Indeed, paradigms such as 'ubiquitous computing' and 'ambient intelligence' imply the 'disappearing computer'. [1] Information and communication, enabled by computation, are increasingly available anywhere and all the time.

As hardware becomes increasingly miniaturized and computing power increasingly distributed, discrete objects might seem less significant than the capabilities they afford. Even as the information and communication enabled by computation become more universally and ubiquitously available, their forms seem to take up less space. Indeed, the functionality of computers, telephones, and music players are already converging in devices with shrinking form factors. The bulky mechanical parts and complex inner workings that industrial design has long been charged with packaging – and interface design with representing – quite literally disappear in ubiquitous computing. 'Hard'-ware may seem less substantive altogether, as such technologies may be more aptly characterized in terms of processes, services, and experiences. [2]

Introduction
Technology and design
Technology and ubiquity

Thus, so-called 'post-industrial' technologies have been described as part of a tendency toward increasing dematerialization or immateriality. In design discourse, this leads to consideration 'beyond the object', in which focus is no longer exclusively on the result of production, or end product. The post-war paradigm shift from mass production to mass consumption resonates in tendencies to think beyond the industrial production of goods to the post-industrial production of experience – beyond discrete objects to product environments, service ecologies, and user experiences. Such tendencies have engendered a range of responses in discourse and practice. For example, perspectives influenced by phenomenology, sociology, and pragmatism 'return to things' in new ways, even as contemporary approaches within the applied arts revisit form in terms of material and critical potentials.

The sections below expand on contemporary tendencies in technology and design that situate the main conceptual, disciplinary, and research frames for this text.

Technology and ubiquity

Where technology meets use, design has long been involved in the interfaces and interactions between. The design of 'user interfaces', particularly as traced from roots in industrial and graphic design, focuses on the tangible mechanisms and graphical representations that mediate our interactions with computational things. Indeed, interaction with computers involves a rather complex interplay between hardware and software – for example, as input via a touchpad, mouse, or buttons map to content display and navigation menus in graphical interfaces. How these elements are designed, mapped to an 'information architecture', and built up into an 'interaction flow' have long been central to interaction design in practice. As the information and communication available through such interfaces unfold over time, even evolving within networked systems of spatially co-located or remotely-distributed objects, issues of interaction also overlap with 'service design' and 'experience design'. [3]

As technologies become increasingly pervasive, so do human-computer interactions. The 'computer reaching out' has shifted, historically, from operations upon electronic hardware by specialists to manipulation of graphical and tangible interfaces that are more widely accessible and 'user-friendly'. The shift continues, to sensor systems that adapt automatically, based on computer perception of contexts and activities – even intentions and moods. Such advances have spurred a range of research topics such as 'unremarkable computing', 'seamless interfaces', and 'everyday computing', which explore interaction beyond direct manipulation and explicit acts of task-based use, but as continually available on the periphery of attention, implicitly adapting and even invisible in use. The user interface extends, literally, beyond the eyes and fingers, into the everyday surround, social dynamics, and intimate experience. [4]

One implication of such developments is an the need to consider other aspects of use than those bound to the physical or spatial form of technological objects. Indeed, there has been much concern for cognitive, emotional, and phenomenal experience in the field of Human-Computer Interaction (HCI), and the situated and social dynamics of work and learning in the fields of informatics and Computer Supported Cooperative Work. As technologies become increasingly pervasive, proponents in these fields are beginning to challenge the primacy of values such as instrumentality, rationality, and efficiency. Instead of the needs that may characterize traditional workplaces and tasks, more widespread consumption requires consideration beyond the direct use of discrete objects to what it might mean to 'live' or 'dwell' with such things embedded in everyday spaces and social lifeworlds. [5]

Introduction
Technology and design
'Beyond the Object'

Such consideration also shifts attention from the spatial form of technological objects to more dynamic qualities. Indeed, computational technologies are particularly, even primarily, temporal in nature. Computer programs are executed sequentially, and interactivity entails that users may determine computational processes underway. Technological objects – 'things that think' [6] – evolve structurally over time, whether through explicit interaction, implicit sensing, or collective intelligence within network systems. Even as such things might seem to evolve a sort of artificial intelligence or life of their own, they are also increasingly integrated into everyday life. In addition to the temporal dynamics of computation and interaction, technologies have long-term effects, on behaviors and relationships, in social change and cultural memory.

'Beyond the Object'

A range of rather disparate perspectives collected by John Thackara under the theme 'Beyond the Object' in the 1980s constituted a 'postmodernism of resistance' against the abstraction, atonality, and atemporality of modernism as taken over by corporate capitalism. The shift from modernism to postmodernism paralleled the shift from industrialization to postindustrialism – inseparable from technological change. Amid the economic downturn and neo-conservatism of the time, the technology boom on the horizon seemed to promise a range of new possibilities. Proponents celebrated the potential of narrative and affective techniques enabled by 'humanware', 'softecnica', and 'dynamic images' – rather than static objects – and vernacular, 'undesign', and 'continuous redesign' – in place of design. Quite literally, as Thackara borrowed Marshall Berman's phrase (in turn, from Marx) – 'all that is solid melts into air'. [7]

Rejecting the modernist correlation of form with hardware (technology as product), postmodern perspectives correlate form with software (technology as process). This reflects technical changes – a shift from the industrial machinery of the Mechanical Age to the dynamic technologies of the Information Age, from goods to experience. Rather than adapting to the modes and products of industrial production, any range of uses and users may be accommodated by technologies that are multi-functional and

configurable, updateable and disposable. Part of a wider societal shift in ideology and consumption, populism, plurality, agency, and consumer democracy displace ideals of functionalism, standardization, and the universalizing tendencies of the modernist 'International Style'. In discourse, 'meaning' gains primacy, whether in the terms of phenomenology or sociology, communication theory or media studies. [8]

One implication is that the 'object' of design attention now seems to exceed that of discrete objects or even traditional categories of objects. In theory, objects may be reduced to mere props in personal meaning-making, as touch-points in network society, or as byproducts of systems of signs. With the increasing importance of media – as technology and as mass-medium – design not only interfaces between technology and use but mediates between commerce and culture. The growing trend has been to promote design in generic terms as 'style', as that which 'adds value' and 'brand equity' in the 'experience economy'. As designers become stylists for any message, design enters 'the culture of marketing' as the 'marketing of culture'. If everything – beyond the object – may also become design, then any 'thing' might become less important than what it stands for, signifies, or sells. Even as process might occlude product, meaning has come to obscure materiality. [9]

Return to things

Another, perhaps paradoxical, implication of the increasing immateriality of post-industrial technologies and the disappearance of computers is a return to things. To the extent that such technologies are sensitive to local contexts, relate to human activities, and invite interaction, they must be present – made perceptible or 'materialized' in some way. As the boxes and screens by means of which computation has traditionally been presented to us shrink, their contents and capabilities disappear – back into surroundings that become newly 'sensitive', 'smart', and 'fast'. Beyond mere 'use', living with such things involves appropriation and adaptation, which are material as well as socio-cultural practices. Even as the presence of computational and interactive things must somehow be designed, both temporally and spatially, they intertwine in ever more intimate ways with our material culture in everyday life.

Introduction
Technology and design
Return to things

Such ideas are being explored in and around interaction design discourse. For example, phenomenological and sociological approaches draw attention to the (re)interpretation of things as taken up into actual and ongoing use. Indeed, such perspectives, along with those in science and technology studies, understand things not as predetermined by design but as appropriated into ongoing 'construction work' involving processes of incorporation and domestication. Returning, philosophically, to 'things in themselves' and, methodologically, to observation of ordinary use, this draws attention to things within embodied action, situated interaction, and social practices. In such terms, physical and material things are in focus – not in the familiar forms typically the 'object' of interaction design, but in terms of material and social practices more in focus in traditional design domains and in other fields of study. [10]

Indeed, 'things' are being rediscovered in various disciplinary discourses. For one, artifacts are prominent in intersections between technology and social science, such as sociotechnical studies of consumption and sociology of technology. Micro-oriented and 'wild sociologies' seek the 'missing masses' and 'interactional what' embedded in mundane personal and social practices. Embodying and extending ideologies into such practices, artifacts are understood to be powerful forms of life. Further, preoccupation with 'visual culture' in art history has meant that design history and material culture have become more distinct, challenging the primacy of visuality and aesthetics by looking to social anthropology and cultural studies. Such approaches take up the complex and evolving 'life' of things, in social and material terms. [11]

In design practice, form is also under reconsideration. Both the modernist 'formal order of objects' and postmodern 'system of signs' have engendered reactions in the applied arts. Contemporary architects are renewing 'material practice' in both pragmatic and critical terms. Product design influenced by conceptual art and radical crafts contest design as only problem-solving or stylish packaging. Rather than merely existing to refer to something else – as in objects conceived only as inferior reproductions of 'ideal types' in a static order or as props in endless 'signification' – things in themselves are a basis for reflexive enquiry in 'conceptual' and 'critical' design. Part of a 'critique from within', posed by practitioners on their respective discipline, the 'object as discourse' posits things as a basis for reflection in and upon design. While ideas may be central, such 'objects that talk back' require use, reflection, and action, through their very physical presence, materiality, and craft. [12]

Starting points

Another way of considering the contemporary context is that as technology becomes increasingly pervasive – as product and/or process – it is not so much disappearing as integrating into new and familiar forms. This certainly opens further application possibilities – for example, as computer and materials science converge in smart fashion and intelligent environments – extending deeply into domains historically occupied by traditional design disciplines. Indeed, as the boxes and screens previously central to interaction design shrink and disperse, the 'object' of interaction design is increasingly that long the focus of concern and practice in such disciplines.

Introduction
Technology and design
Starting points

This implies a need to consider technology on the terms of design. In such terms, we might think and work differently – for example, since appearance and functionality have long been deconstructed in the applied arts, other values might gain primacy, such as affect, performativity, and agency. Asking not only 'how' but 'why' and 'when' technology might be applied and used, we might query its ubiquity and effects, as in the debate over 'total design' and 'good design'. Use might be explored beyond consumption or usability, as active participation and sustained experience. While early discussions 'beyond the object' were remarkably uncritical of technology and use, we might update and extend the discourse in interaction design.

Just as applied artists might contest design-as-service or -styling – practice might be expanded as an arena for material and critical debate. Indeed, as technologies become more pervasive, they are also more accessible to fine and applied artists, evident in widespread experimentation with new materials. Besides what can be done in high-tech laboratories or high-end design, modes and methods of experimental practice might also be a basis for (interaction) design research. Such alternatives concerns and practices diversify the range of ideas and artifacts that might be extended to users and into use, opening up new prospects for reflection and participation.

Lastly, as technologies become increasingly pervasive, interaction might be a basis for reconsidering form. A return to design and form is not to be confused with a return to convention and 'formalism'. Certainly, a contemporary account need not be on the terms of an art historical 'will to form', of modernism's 'formal order', or of postmodern 'system of signs'. Instead, form might be reconsidered in terms of the social and material 'life' of things. That is, form might be conceived as part of a more general 'return to things', shaped by material, social, and (sub)cultural interactions – over time. Things might be rediscovered both in spatial – and temporal – form.

Main concepts

This text attempts to locate some particular concerns of interaction design within this expanded – and rapidly expanding – field of relations between technology and design. Post-industrial technologies have introduced a range of temporal dynamics particular to computation and interactivity, reflected in a shift towards 'process', rather than 'product', in design discourse and practice. This affects how we might think about form in general, as such technologies are increasingly integrated into familiar materials and ordinary things. Form, as such, may not only be characterized in terms of immediate and perceptible presence in space, but in terms of change in time – 'temporal form'. [13] As outlined below, various temporal notions are explored as concepts in design and as undergoing considerable revision in contemporary thought. 'Form' is revisited in this text, in terms of the temporality of materials, use, and change, inflected by concepts such as becoming, making, and futurity.

In interaction design, we are perhaps most accustomed to thinking about the scale and scope of proximate use – interactions performed directly and in real-time. While accounting for the temporality of embodied interactions and flow of experience, there are other concepts that become increasingly relevant as technologies become integrated and pervasive in many forms. For example, architecture provokes other temporal concerns – sheer mass and cultural commitment invested in the built environment entails a certain resistance to change and persistence through turnover in use and users. This opens up for considerations beyond the space and time of proximate use, to material dynamics, sustainable experiences, and cultural effects. As a basis for relating to changing temporal form and the form of ongoing interaction, time-related concepts in theory and in architecture provide a discursive context for locating concerns in the shifting ground in and around interaction design.

Introduction
Main concepts
Time and form

Time and form

'Space' has engendered many discourses and practices – architecture, urbanism, geography, and geology might be understood as occupied with the study, articulation, and regulation of space. Time might only too easily be reduced to standardized units, by which spatial phenomena might be measured, quantified, and described. Indeed, modernist theories tended to perpetuate categorical notions – space versus time – in order to transcend historical grounds, order future uncertainty, and render knowledge somehow more transparent. For example, rationalist, formalist, and mentalist models in architecture separated subjects and objects, form and function, mind and body, as independent variables in descriptive and predictive schemas. Thus delimited, the real might somehow be contained and related to an abstract ideal. Design might fix the essential 'zeitgeist' – or spirit of the time – in spatial form. [14]

In contrast, theories of relativity, Gestalt, metabolism, cybernetics, and vitalism have prompted other conceptions of spatial-temporal relations – as in notions of fields and forces, growth and decay, entropy and feedforward. More recently, complexity has undergone further reconsideration – previous bio-technical logics of the vitalist or mechanist kind have been challenged by other paradigms. In part, those of new technologies have superseded those from the natural sciences or industrial management, even as information networks and communication systems have infused the built environment and societal relations. It seemed that spatial morphologies alone could not account for social complexity – reflected in scientific attention in 1968 to catastrophe theory and the application of 'chaos' and 'cellular automata' to complex systems of all sorts and, in design, attention to cultures of plurality and difference, protest and transgression, populism and consumerism. [15]

Interactivity interjects new temporal dynamics. Even the term 'interaction' implies time – as originally used to describe reciprocal influence in the physical sciences and, as taken up in the social sciences, to describe interpersonal communication. In addition to the temporal dynamics of materials, in which interaction might be considered in biological, mechanical, or chemical terms, computational processes are executed in time and may evolve in diverse ways. With interactivity, such processes depend on the actions and reactions of people to unfold at all – indeed, since not all of such a complex system may be directly or immediately available, processes of use become necessary to unfold and direct computational processes. The ability of such systems to be changed over time introduces dynamics of participation, interdependence, and indeterminacy, as computational processes are negotiated in situated acts and cultures of use. Technological complexity meets societal complexity in the interfaces between, in interactions with profound effects on technical and social systems.

Such temporal concerns resonate with tendencies in contemporary thinking. A shift from 'product' to 'process' returns us to things – not as static entities transcending the contingencies of time, but as enmeshed in histories and affecting futures, always in the process of 'becoming' through material or human interactions. While such processes might be studied retrospectively, or abstracted into patterns for future predictions, much of what happens is beyond the scope and scale of discrete objects, individuals, or interactions. The 'life' of things might be understood as continually 'in the making' – by nature, by design, and in use – affected by more or less knowable factors in ongoing socio-cultural lifeworlds. 'Futurity' thus exposes certain limits of design, a certain 'outside' to what might be known, predicted, and controlled. [16]

Concepts of 'becoming', 'in the making', and 'futurity' are drawn into a discussion of temporal form in this text. This opens for consideration of dynamic material composition, for the role of use and users, and the responsibility of design for its effects.

'Space, Time and Architecture'

While architecture might seem to be the ultimate object-oriented discipline, time has long been central to discourse and practice. At the turn of last century, the elevator, telephone, cinema, and the airplane shattered previously dominant conceptions of spatial-temporal relations, generating new concepts, techniques, and forms. The Futurists explored the 'dynamic plasticity' of materials to express 'space-time', Le Corbusier applied the logics and aesthetics of the Machine Age, and the Bauhaus included the 'space between objects' in a total conception of design. In discourse, Siegfried Giedion expounded on 'Space, Time and Architecture', Bruno Zevi explored the fourth, or temporal, dimension in 'Architecture as Space', and Henri Focillion conceived of the 'life of forms' in terms of 'forms in space' and 'forms in time'. [17]

Indeed, the spatial conditions of architecture entail a significant occupation of time. Architecture does not lend itself to rapid replacement or mass production – the mere fact that buildings are embedded in the ground retards the cycle of production and consumption. Buildings are generally intended to last – through turnovers in occupancy, functional changes in program, political changes in zoning, and retrofit of new technologies. Just as the built forms making up the city are always in various stages of evolution, renovation, expansion, and decay, site, structure, surfaces, and services continually undergo change. Design involves a certain indeterminacy and foresight – in addition to satisfying immediate concerns of clients and present-day functions, architecture must remain relevant for unknown users and future use. [18]

As a discipline fundamentally concerned with space, temporality may be approached differently than in other domains. Certainly the evolution of the built environment

might be taken merely in bio-technical terms, for example in terms of the properties of its constituent elements and materials. However, value is also a cultural, historical, and political matter, since architectural forms are sustained through critical mass of use over time and ongoing relevance in cultural memory. Indeed, architecture not only accommodates – but effects – behavior, rituals, and power. Architecture is quite literally a 'disciplinary practice', enforcing particular ideologies through the design of spatial and temporal regimes. Due to its substantial and powerful spatial occupation, architecture may be considered – by design and in use – in terms of materials and evolution, appropriation and adaptation, even subversion and change. [19]

In such terms, architecture is profoundly process- as well as product-oriented. For example, 'vernacular' forms are not so much a direct product of design but of evolution through historical and cultural occupation – such long-term and large-scale use entails consideration of openings for use as participation. Between the hard facts of 'spatial syntax' and soft practices of 'social praxis', notions of 'event' in architecture conceive of form as infrastructure for the eruption of the unexpected, whether personal narratives, (sub)cultural performances, or emergent practices. Indeed, querying the architectural determination of change, conceptions of 'non-design' contest design as service to ideology and prescription of use. These perspectives expose the resistance of form – considered in both spatial and temporal terms – to simplistic dichotomies between im/material, soft/hardware, and in/determinacy. [20]

Notions of 'event', 'vernacular', and 'non-design' open up for consideration of technology as material, use as participation, and critical design. Here, this is a basis for expanding on relations between spatial and temporal form, at various scales.

Introduction
Main concepts
Themes

Themes

It becomes apparent, thus, that time must not only be central to interaction design, but that there are multiple temporal concepts, and spatial-temporal relations, to be considered. Just as matter is subject to the laws of nature, so is computation, to the extent that it is materialized for users to perceive and act. Manifest through some spatial form, technologies are characterized by the temporal dynamics of the material world as well as those of computational networks and systems. As interactivity must somehow relate to human activity, the dynamics of lived experience, social situations, and cultural change come into play. Interfacing between technological and societal complexity, interaction design must be concerned with the form – spatial and temporal – of things in large-scale and long-term use. Rather than the spatial preoccupations of 'formalism', such a conception of form returns us to a more fundamental definition – formation both in space and over time.

In this text, time is the basis for enquiry into the particular concerns of interaction design. Since we are perhaps most accustomed to thinking in terms of proximate use, the scope of discussion here is extended – to 'Materials', 'Use', and 'Change'. In each, accounts of time are raised in relation to form and architecture, to develop such concerns of interaction design within an expanded disciplinary and conceptual field.

Materials

In the section 'Material life', views of interaction design drawn from user interface and industrial design are situated in relation to perspectives on complex materials, both those traditional in design practice and new materials that made 'sensitive' and 'sensible' through the integration of technology. I argue that instead of focus on increasing 'immateriality' and historical notions of 'formalism', we must revise our conceptions of form to consider the dynamic properties and performances made possible if we consider computation as a material in design.

In order to relate to qualities of the materials basic to interaction design – that is, both traditional and technological materials – the concept of 'temporal form' is explored in terms established in design. With respect to a discourse around the 'event' in architecture, notions of 'infrastructure' and 'performance' are discussed to situate the (de)composition of design form in terms of intersections among natural, technical, and social systems. In such terms, the material 'life' of things might be understood as an ongoing process of 'becoming'.

Use

The section 'Becoming users' explores the temporality characteristic of discreet acts and ongoing practices of use, both in terms of embodied and situated action characteristic of the phenomenal and social experience of things, and processes of interaction particular to the use of technological objects. Beyond mere consumption, use might be understood to involve significant commitment to engagement with the spatial form and the sustained use of things in everyday life – and to participation in revealing and materializing the functions of technological objects that may only be available by means of temporal processes of interaction.

To some extent, this means that interaction design involves the design of patterns of and behaviors in use. However, I argue, 'use as participation' implies that the form of technological objects might be understood not only as given, in advance, by design, but as materialized during processes of interaction – formation always 'in the making', by design and by use. 'Vernacular' in architecture locates accounts of 'the ordinary', 'typology', and the challenge of 'bigness' as a basis for relating to form as a product of (sub)cultures of use, local and historical evolution.

Introduction
Main concepts
Themes

Change

The section 'Design effects' examines larger-scale and longer-term notions of use. In bringing about the material conditions for the future, design effects surpass solutions to immediate needs or present-day problems. As persuasive design and the sociology of technology reveal, design is a powerful force in determining 'what might be' – and 'what *should* be'. Inevitably ideological, design involves choices about the ideas to be extended into use, inscribing these in the spatial and temporal form of things that become incorporated into lived experience and cultural memory.

The temporal form and the form of ongoing interaction with technological objects entail that design extends to an even greater and more lasting extent into future use. Examination of what falls outside design, or 'non-design', raises questions about the 'ideological transfer' of design intent into use. Further, 'anti-design', 'Non-Plan', and 'post-functional' movements contest design determination of the forms – and norms – of society. Given certain problems with the 'total design' of 'futurity', I argue that we must pay particular attention to the role and responsibility of interaction design in effecting change.

Disciplinary frames

'Design' is a broad term describing a range of practices involving the conception, planning, and production of artifacts including images, objects, services, and systems. In design studies, characterizations run to extremes, from accounts of the professions to an intentionality evident in a range of less formal or lay activities. Academic stances range from design as a branch of the humanities to a 'science of the artificial'. The former might argue for themes such as invention and communication, judgment and construction, decision-making and strategic planning, evaluation and systematic integration. The latter might more generally conceive of broad overlaps among the natural sciences, humanities and liberal arts, social and behavioral sciences, creative and applied arts, professions and services, technology and engineering. [21]

Historically, design might be more identifiable in disciplinary terms – architecture, industrial design, fashion, and graphic design, for example – which still tend to orient the educational and professional context. Today, however, the materiality, methods, and even markets of the fine and applied arts are blurred and contested – a certain 'anti-disciplinarity' characterizes some contemporary practices, just as 'post-disciplinarity' characterizes certain perspectives within the study of design. [22] For one thing, this makes any choice of terminology debatable – given the concern in this text for relations to additional domains and disciplines, the term 'applied arts' is employed to broadly delineate a range of established practices in design. More important, however, is that such tendencies indicate shifts in the disciplinary foundations upon which a discussion might be traditionally based.

Introduction
Disciplinary frames
Interaction design

Indeed, plurality characterizes my own perspective on interaction design, based on experiences within diverse projects, institutions, communities, and countries. For example, while my academic background is in architecture, my practical education in interaction design rooted is in an art school experience and a certain 'Arts and Crafts' orientation. My professional experience includes corporate research and commercial consulting in the UK and USA, and my current research is conducted in the context of Swedish IT research and a particularly Scandinavian tradition of systems development. To some extent, this text is also an attempt to trace persistent concepts through my own experiences over the years, to locate my perspective on interaction design in such a diversified territory of practices and discourses.

In locating interaction design within such an expanded field, a range of disciplinary perspectives are inevitably – and deliberately – involved. However, as a relatively new and multi-disciplinary field, interaction design might too easily treat ideas from other fields superficially, as analogs or metaphors, without closer examination of respective histories, logics, and problematics. [23] In order to treat certain concepts in depth here, architecture is taken as a primary frame of reference throughout. Given my background, it may be no surprise that I have found relations between interaction design and architecture to be substantial and provocative. Complementing interaction design, architecture provides considerable conceptual resources for understanding and working with issues of 'Materials', 'Use', and 'Change', as well as a history of work with related concepts in practice, as introduced and outlined below.

Interaction design

'Interaction design' was coined in 1984 by Bill Moggridge, co-founder of the design consultancy IDEO, to describe an emerging practice of design focused on interactions with technological objects. The field has since developed in various directions, also reflecting technological, economic, and institutional development. As a relatively new field, interaction design is populated by disparate and even competing views.

Associated with Human-Computer Interaction (HCI), with which it is equated in some accounts, concerns include psychology, cognitive science, ergonomics, and human factors engineering. Early on, Gillian Crampton Smith distinguished the 'artist-designer' from the 'engineer-designer', for whom values from the fine and applied arts might be more central than knowledge and method as pursued in the sciences. [24]

Arguably, two of the most formative perspectives in interaction design have been those developed at the Royal College of Art (RCA) in London and at the School of Arts and Communication (K3) at Malmö University in Sweden – the former is where I received my postgraduate education and the latter is where my doctorate is located. Crampton Smith started the 'Computer Related Design' course at the RCA in 1989, around concepts such as the 'art of interaction' and 'computing as craft', explored on a studio-, workshop-, and project-basis. Today, as headed by Anthony Dunne, the course is called 'Design Interactions' and focuses not only on electronics and computing, but bio- and nano-technologies, as well as critical social and cultural implications. K3 combines project work into a more academic framework – traditions of systems development and Participatory Design in Scandinavia inflect a particularly social vision of new media and curriculum developed as a 'Digital Bauhaus'. [25]

It has been at the Interactive Institute in Sweden over recent years that I have been able to reflect deeply on interaction design, as a design researcher and manager in the context of the institute's research in information and communications technology. The Interactive Institute acts to join art, academia, industry, and the public sector – explicitly operating from the outside to create new intersections between domains. The Institute has been set up to encourage collaborations and experimental initiatives that may be difficult to take up or develop to the same extent in other contexts. Our studio in Göteborg has had a particular focus on design research – carried out as research programs presented in this text, as well as more or less formal discussions that have been fundamental to many of the ideas developed here.

Introduction
Disciplinary frames
Architecture

As a relatively new field, perspectives on interaction design as experienced from within, and observed from without, may be quite disparate. Given that educational programs have been developed only recently and primarily on the graduate level, practitioners and researchers in the field are often educated in other disciplines that they then bring to interaction design. This means that there are a variety of more or less inclusive and perhaps conflicting views on what interaction design is or should be about. Particularly when it comes to research, the fault lines between different academic traditions seem to come to the fore, as might be evident in the concerns of conferences, which may be more related – in terms of foundations or funding – to technology, business, science, or the humanities.

Architecture

In interaction design and HCI, there are a few central references to architecture. For example, links to architectural concepts and concerns are often made, perhaps more historically, to Christopher Alexander and Kevin Lynch, and to the contemporary writings of William Mitchell and Malcolm McCullough. Certainly, there have been some remarkable overlaps in communities of practice, whether by circumstance or by intent, for example, within the 'design methods' and 'Participatory Design' movements, and at XeroxPARC, MIT, and Interval Research. However, much interest in architecture remains just that, inspiration from ideas such as 'patterns', 'place', and 'typology'. Such overlaps and inspirations have been important to widen the discourse within interaction design – however, there are other proponents and ideas within architecture that may also expand – and challenge – perspectives. [26]

A danger in multi-disciplinary work is that we choose ideas on the basis of what might, on the surface, seem typical or well-established – classical ideals, modernist paradigms, or academic theories that may only form a general or textbook backdrop. Indeed, relating only on the basis of ideas might easily detach from the original theoretical concerns and historical context – architectural ideas might be subjected to critique on the basis of other theories and different histories. For example, certain concepts in architecture might be marginalized in research premised on customer or user-centered models, whereas they might well enrich ideas in interaction design on other grounds entirely. [27] Such tendencies have entailed that architectural proponents and ideas widely known in interaction design are not present to nearly the same extent or for the same reasons within architecture itself.

While to a certain extent difference in interests and interpretations across disciplines is unavoidable, merely skimming the surface might miss the truly challenging and hotly contested ideas at the heart of architecture. Architecture has a long tradition, thousands of years old, in approaching theoretical and practical issues in design. As one of the most established disciplines, architecture has a strong center of gravity, extensive theoretical, historical, and practical foundations. This supports a broad continuum of ideas, from those that are well-established or conservative to those that are experimental or radical. Rather than those already familiar in interaction design, this text delves more extensively into others.

Such ideas are particularly interesting as they evolve within practice – that is to say, evolution on the basis of work and critical discourse among multiple practitioners over time. Thus, theoretical architects, rather than architectural theory, are emphasized here, situated in relation to one another. While there are perhaps more provocative and contemporary examples, more established and well-published proponents are emphasized here, including many who have worked or taught together in places where I have also worked or studied. This enables a certain common ground as a basis for building up a certain breadth and depth of context around concepts.

Introduction
Disciplinary frames
Practices

Relating architecture and interaction design is not a simple matter – nor should it be, if we wish to avoid relating merely by superficial analogy. There might be certain shared concerns – for example, conceptions of 'time' as indicated above and as central to this text. Indeed, rather profound discursive and practical relations are suggested when such concepts are examined in some depth – not merely for the purposes of comparing and resolving but for exposing and juxtaposing differences. Of course, since the primary concern here is interaction design, this text undoubtedly lacks the completeness and rigor that would be requisite in a comparable text in architecture. And, vice versa, certain discussions in interaction design are merely outlined in order to give space for developing architectural relations in more depth.

Practices

Various approaches might be taken to relate between different fields of practice, particularly given a rapidly expanding field of possible relations today. One might be a sort of 'disciplinary project', developing foundations held to be unique to a discipline, such that it might be compared and defended to others. Indeed, relations between design and science have prompted investigation of respective knowledge interests – this might be a basis for such a project in interaction design, or even design in general. Another, perhaps 'diplomatic project', might be to include heterogeneous 'schools of thought' within a comprehensive theory. Still another might be to analyze the gaps within theoretical foundations, for example as those of interaction design have been cobbled together from multiple disciplines over time. [28]

Locating foundations for interaction design is no simple matter. Indeed, the technologies central to interaction design are deeply implicated in increasingly blurred boundaries between domains. The prevalence of computation in any range of practices and products, along with widespread experimentation with notions of interactivity, imply increasing overlaps in materials, methods, and concerns across disciplines. Further, increasingly pervasive, accessible, and open technologies imply an increasing permeability between 'those who design' and 'those who use'. Even as any range of creative practices might incorporate technology, any range of people might adapt and create technological things. Such tendencies parallel the anti- and post-disciplinary stances in contemporary design discourse.

Additionally, my own perspective is influenced by experimental work, conducted by individuals or collectives who might qualify themselves as artists or activists, conceptual or critical designers, rather than subscribing to conventional terms of academic disciplines or design production. While such activity might fit in a history of 'criticism from within' architecture, there is little basis for relating to or among such approaches in interaction design. Within and between disciplines, much significant activity is underway that may not coincide neatly along common front lines, in established terms for evaluation, or comparable foundations for discourse. I might even argue that interaction design might be essentially characterized by multiple fringes – rather than foundations – at the edges of various disciplines where they overlap with others.

Introduction
Disciplinary frames
Practices

Two strategies are pursued to relate to such a disciplinary situation here. First, taking architecture as a primary frame of reference allows a certain juxtaposition of ideas while evading 'border disputes' that might crop up in the shifting ground within and around interaction design and more closely related fields. Such juxtapositions are not meant to address questions in one field with answers from another – differences in materials, history, and production are rather self-evident. While ideas from industrial design or computer science may have long been assimilated, architecture throws certain assumptions into sharp relief. Thus, such a frame of reference acts as a consistent – even systematic – basis for examining issues raised throughout.

Secondly, to the deeper histories, logics, and problematics of certain ideas, implications of concepts explored in 'Material life', 'Becoming users', and 'Design effects' are taken further as a discussion of issues and conditions in practice. In sections on 'Material practice', 'Participatory practice', and 'Critical practice', strategies and examples are collected on the basis of (more or less) established 'communities of practice'. This enables a certain contextualization – and critical comparison – between experimental or unconventional tendencies across diverse disciplines. Additionally, it provides an alternative framework for establishing shared concerns.

Material practice
In 'Material life', dynamic performances of traditional and technological materials are explored in terms of temporal form, (de)composition through natural, technical, and social interactions over time. Increased integration implies increased intimacy with new materials in everyday life – however, in design practice, technology has been associated with increased abstraction and distance from materials and making. Existing discussions of 'design materials' and 'computing as craft' in interaction design are starting points for considering how to work with technology as a material.

Without reverting to nostalgic notions of craft nor purely instrumental notions, technology is considered in terms of various material traditions. 'Expressionism', 'D.I.Y.', and 'weaving' in the applied arts, for example, present alternative ways of experimenting and developing material expressions – including combinations of the old and new,

high- and low-tech materials central to practice in interaction design. As a sort of basic 'material research' or even 'material culture research', I argue that a notion of 'Material practice' might join a range of technical, aesthetic, and critical concerns.

Participatory practice
Interaction involves more than an all-purpose choice to consume or even repeat and sustained use, as discussed in 'Becoming users'. Since technological objects require interaction to materialize operations and information, users participate in ongoing formation. However, as ubiquitous and invisible technologies become naturalized into everyday lived experience, it may be easy to forget the agency in (inter)actions. Breaking down the distinction between 'producers' and 'consumers' inherited from industrial production, new technologies might support (sub)cultures of participation.

Rather than mere 'users', downstream of ideas and behaviors designed into objects and interactions, hobbyist and activist activities open up for other perspectives on participation in and through the products of design. 'Participatory Design', 'tactical media', and participation in architecture, for example, work with issues of power, risk, and responsibility – within processes of design and various tactics of use. As essentially concerned with such new forms of technology and interaction, such issues are central to interaction design, as I argue in the section on 'Participatory practice'.

Critical practice
Circumscribing everyday practices, as discussed in the section on 'Design effects', objects enable and disable behaviors. To the extent that objects prescribe how they might be used, interaction design involves anticipation and determination of future use. However, just as design is not an exact science, neither does use merely involve lived obedience to, nor efficient translation of, design intent. The products of designs continue to be negotiated, as the ideas inscribed by design into the form of objects and interactions are taken up into subsequent practices and cultures of use.

Considering intent and agency requires further development of 'Critical practice' in interaction design – not only for considering accountability in professional terms, I argue, but in terms of social, cultural, and political effects. For example, 'conceptual', 'concept', and '(post-)critical' tendencies already operate as a sort of 'criticism from within' architecture and the applied arts. Surpassing reflection upon design practice or analysis of critical theories, alternative ideas inscribed into design products open up for 'active critical participation' outside and after design.

Introduction
Disciplinary frames
Practices

There are also, of course, diverse possible relations between design and research. From the perspective of applied research, a typical suggestion is that academic research should strengthen ties with industry and act as an incubator for innovations that will improve practice and products. From academia, applied research projects might seem narrow in scope, often regarded as second- or third-rate quality. In the arts, 'practice-based' perspectives situate research within practice – challenging academic prescriptions of transparency of method and replicability of result, which do not necessarily relate to validity or quality in design practice. Locating design research in relation to industrial, academic, and artistic perspectives is no simple matter.

A more general ambition in research might be to improve practice. However, it is by no means self-evident how to qualify either 'improvement' or 'practice' in the current context, given problematics of anti-, post-, and multi-disciplinarity. Indeed, (post-) critical tendencies might contest the very idea of foundations, authority, or validity, along with any simplistic conception of 'good design' or 'best practice'. [29] Further, in interaction design, any number of technical, social, and critical practices might be involved in complex problem settings and collaborative project situations. Between interaction design and architecture, rather different theoretical and operational conditions mean that the meetings between may not match precisely, or even at all.

Introduction
Research and practice
Problem-solving

This presents certain challenges for positioning a perspective on relations between design and research in interaction design. For one thing, since this text sets out to expand and diversify perspectives on the main concepts, a number of historical, epistemological, and ideological positions are already present, implicit in approaches and examples drawn into the discussion. While it is not the scope of this text to analyze such bases, certain positions are outlined below, as a context for further discussion taken within 'Material practice', 'Participatory practice', and 'Critical practice'. In addition, such challenges in positioning suggests that we might consider other ways of framing interaction design research in practice that might account for and benefit from diverse ways of thinking and making in the contemporary situation.

Problem-solving or -finding?

A common characterization of design is that it is essentially about 'problem-solving'. However, while problems in specialized fields may have definite conditions, there is a fundamental indeterminacy in all but the most trivial design problems. Rather than objectively given, there is no authoritative set of rules, criteria, or methods, nor any ultimate test of validity for problems and solutions in design. Any design brief set for such 'wicked' problems, as Horst Rittel and his colleagues characterized them, can only be understood as an open framing of a set of issues with many possible resolutions. [30] In responding to such problems, some questions may go unanswered, new questions or even problems generated.

Such a formulation in the 1970s contrasted with analytic and rational conceptions, as treated by certain proponents of the design methods movement and in Herbert Simon's 'The Sciences of the Artificial'. In such conceptions, problems were treated as variations of basic formulas, which might then the subject of rational problem-solving through means-ends analysis and the rigorous application of logic. In such views, it may seem as if inherent uncertainty is merely to be tolerated – that research should be about improving, and design about applying, methods for managing or reducing uncertainty. Such views tended to emphasize specialized, objective, and fundamental knowledge with science as the prototype – often separating 'things to know' and 'ways of knowing', knowledge and action, theory and experiment. [31]

Such embedded biases might produce some undesirable consequences. For one thing, if science is taken as the prototype for design, so might its conception of problems, methods, and validity. Indeed, as Richard Buchanan has pointed out, one consequence of the difficulty in understanding design problems has been that the sciences have tended to regard design as an 'applied' version of its own knowledge – design can be seen merely as an instance, practical demonstration, or 'packaging' for principles and discoveries made elsewhere. Design might only ever aspire to be a (second-order) version of science – or art, for that matter. [32]

Indeed, such separation is rather deeply embedded within university systems and professional categories as 'technical rationality', and a tendency to separate and privilege research and theory over design and practice. Research might be posited as that which generates and provides knowledge, while practitioners might merely study problems, apply research, and test results. Even attempts to expose the knowledge and ability within design practice – as in valuation of divergent rather than convergent modalities, minor versus major professions, weak versus strong disciplines – may perpetuate an embedded hierarchy. Even attempts to fortify design in education may merely reinforce this, by emphasizing formalism, technique, intuition, and application, rather than critique of sources of knowledge. [33]

Alternative perspectives, for example those informed by pragmatist and phenomenological thinking, may focus instead on 'problem setting' and 'design situation'. Arguing that a focus on problem-solving obscures the social construction of problems themselves, Donald Schön emphasizes the particularity of each problem setting. In his notion of 'reflective practice', experimental action is not merely seen as a test of theory conceived separately and in advance, but as a generative and propositional mode interwoven with reflective and situated practice. He describes an interplay of thinking and making – "When someone reflects-in-action, he becomes a researcher in the practice context." [34] In contrast to approaches based on technical rationality, local and personal dynamics, participation and intervention have been central within 'action research', as set out by Schön and Chris Argyris, and others.

Rather than objective knowledge or abstract theory, which might be conceived of as above or in advance of practice, practice understood as situated and social gives primacy to subjective interpretation and practical experience. Pelle Ehn, for example, argues that since design is fundamentally about transcending that which is given in the present, a scientific heritage in analysis and rational extrapolation of existing conditions has its limits. [35] Indeed, the diversity of those who are stakeholders in design processes and in eventual products implies that multiple social, technical, and critical positions must be engaged. Arguing for a basis in human practices and ordinary language, Ehn understands design as an essentially emancipatory practice – as processes and products effecting material transformation and social change.

Rather than a rational or deterministic account, in which a given problem begets a solution through the rigorous application of objective knowledge or systematic logic, these may be more or less important factors in different problem settings or design situations. Indeed, in architecture, normative theory and technical rationality have long been challenged on the basis of 'Critical Theory', as posed by the Frankfurt School, and 'critical theory', as more generally referred to since French poststructuralist thinking, including any range of marxisms and femininisms, psychoanalytic, historical, and cultural studies. For example, long-standing conceptions of 'praxis' compound appreciation for intellectual mindfulness or abstract 'ideal' with practical negotiation and active transformation of the 'real'. [36]

Further, pragmatic reflection might be extended as a critical modality – to question and transform, rather than only describe and analyze. As propositional and generative, practice is not bound to what is given, in advance or from outside. Jane Rendell argues for 'reflection in action' in architectural research, but extends this to modes of critical discourse and practice more central to the discipline. [37] She argues for design and research that critically rethink the parameters of a problem, theory, or institution. Indeed, making in itself – particularly making experimental forms and conceptual artifacts – acts as a critique of the paradigms of knowledge held in the architectural profession and building industry.

Perhaps an important factor that separates practice-based research in design from other types of research is the possibility to consider processes and products as a mode of 'discourse'. Rather than affirming material, social, or political norms, Anthony Dunne and Fiona Raby argue for taking a critical stance in relation to conventional or professional practice. Designing, according to Dunne and Alex Seago, might be seen quite literally as a sort of "conceptual modeling", objects as a "material thesis", in a practice of "socio-aesthetic research". Perhaps, as current thinking might suggest, the most radical potential of theory in design might be to engender skepticism or doubt – 'problem-finding', to borrow a phrase from anti-design. [38]

Introduction
Research and practice
Program

Such approaches suggest that perhaps the work of theory in design is not to fix problems as statements or claims but to conceive of them as open questions, forcing us to reflect, experiment, and act. Rather than merely tolerating uncertainty, and making every attempt to systematically reduce and manage it, research might be a basis for opening up and exposing problematics. Resulting objects may not solve problems in professional practice – instead, they may critically rethink the parameters of problems altogether. Perhaps one characteristic of doing theoretical work in design is not simplification but diversification of the ways in which we might understand design. In such terms, design research might not be about solving problems or resolving uncertainty, but opening up for complexity and criticality.

Program

Disciplinary distinctions are often put forth as a basis for qualifying value and validity in design research. For example, the epistemological accountability of science and the aesthetic accountability of design might be distinguished, along with respective standards of valuation, whether set by academic tradition and peer review, market value and critical reception. [39] However, such distinctions may not fully account for the disciplinary, collaborative, and experimental conditions in interaction design research.

In many accounts of practice-based research, a design process seems to be equated to a research methodology – for example, as a systematic investigation of methodological or material issues within a distinct art, craft, or design practice. This may well characterize enquiry carried out on an individual basis, in which generative, propositional, and discursive modalities might be articulated within practice and inscribed into some sort of 'product'. However, as Rendell has pointed out, in multi-disciplinary work, the same product might be the result of multiple concerns, methods, and criteria folded into a collaborative practice of design and/or research, valuations of which might contradict or conflict with one another. Thus, valuation on the basis of disciplinary distinctions may not fully account for the intersection of technical, social, and critical concerns in practice-based research in interaction design.

Further, critical and experimental practices engage with disciplinary and theoretical frameworks – and respective values – but do so in order to raise a critique. For example, 'use value' or utility might be disrupted through strategies drawn from art

into conceptual design, 'exchange value' might be critiqued in terms of participatory or societal values, and the 'sign value' of appearance might be eclipsed by open, ambiguous, or interactive forms. A number of such strategies, discussed in relation to interaction design in the sections 'Material practice', 'Participatory practice', and 'Critical practice', might be understood as part of contemporary post-structuralist and post-critical revisions of traditional criteria and categories of valuation.

Such issues certainly pose challenges to design theory, but it is also important to consider how to carry out design research amidst such contestation. Thomas Binder and Johan Redström describe an approach that characterizes much of the work in which I have been involved at the Interactive Institute. [40] As a "program", a set of theoretical and experimental strategies – and relations between – might be crafted as a 'provisional knowledge regime'. To the outside, it is made clear that it is only one of many possible approaches, while a common ground is set for constructive and collaborative work. In this way, a provisional overlap is constructed to bring together the particular characteristics of individual practices, communities of practice, or disciplinary frames, producing 'products' that exemplify conceptual issues and problematics on a programmatic – as well as individual, project, or disciplinary – basis.

'IT+Textiles', 'Public Play Spaces', and 'Static!', for example, combine multiple disciplines into experimental, collaborative, and practice-based design research. These are programs in which I have been involved, whether in carrying out, managing, or directing the actual work, thus providing a further and more concrete basis for grounding a discussion of main concepts in this text to issues of research and practice. While these programs, and projects within them, are by no means direct results or even exemplary of the main concepts and themes, I draw out certain topics for retrospective reflection and speculation on programmatic and wider implications.

IT+Textiles
Joining information technology and textiles, the design research program IT+Textiles investigated new aesthetics and applications for complex and dynamic material expressions. Participating partners and individuals came from diverse domains, including the traditional textile industry, high-tech and design companies, and universities. 'Experimental design' situated an approach to hands-on and collaborative experimentation, both in the program as a whole and within project work.

Public Play Spaces
Public Play Spaces drew on art and architecture to catalyze debate about the role and effects of technology in public life. Pursued at the fringes and parasiting off of other programs and projects, methods from Participatory Design, Situationism, game theory, and performance were intervened into ideation phases, development processes, and evaluation situations, in order to pose questions and try out alternatives together with participants, stakeholders, and in public.

Static!
Investigating design for energy awareness, Static! combines critical technical and design practices. A series of product concepts was developed in which energy was rendered more visible and tangible through dynamic material expressions. Producing both conceptual designs intended for public consumption and desirable products for use in the real world, the program explored how product and interaction design might support reflection and behavioral change with respect to energy use.

About the form of the text

Assembling this text has been a project in itself, as much a project of curation and construction as of theorizing and writing. My own ideas are present not only in words, but in how those of others have been collected, situated, and juxtaposed. In addition, projects are present as self-contained portfolio or documentary pieces, placed within the original parameters of their commission and collaboration – anchored into the text by means of open questions posed as speculations. Inserted project pages are an attempt at 'roughening' the flow of text, to excavate certain formative examples from my own experience, to interrupt, punctuate, and even complicate the text.

As a project in itself, this text has been constructed in particular ways. The three themes were a framework for exploring and expanding conceptions of temporal form in interaction design. If focus is typically on the scope and scale of proximate 'Use', then 'Materials' scales down to consider the more basic composition of form, the materiality and temporality of 'atoms and bits', and 'Change' scales up to consider large-scale and long-term design effects. Thus the thematic progression also frames a progression in scale, from the basic material components of form, to the use of such forms, to the wider effects of form in use.

Introduction
Research and practice
About this text

Within each thematic frame, content has been developed on the basis of a particular construct for relating to design research. Cristopher Frayling makes distinctions between: research – 'into', 'for', and 'through' – design. [41] Research 'into' design is the most traditional, for example involving historical or aesthetic research on design as commonly pursued in art and design history. Commonly referred to as practice-based or -led, research 'through' design might describe experimental or action research carried out by working with particular materials, techniques, and technologies, to further develop with might be done in a particular practice or application domain. Research 'for' design ends in artifacts, which refer to and embody larger theories and concepts in material form.

This construct has been a rough guide for developing a discussion of thinking and making within each theme. The first sections of each theme, 'Material life', 'Becoming users', and 'Design effects', gather various ideas on design, drawn from historical, aesthetic, technical, and other perspectives on interaction design and architecture. The last sections in each theme, 'IT+Textiles,' 'Public Play Spaces', and 'Static!', orient certain ideas through my own practice in interaction design research. Thus, arguments within each theme are approached from the top-down and from the bottom-up, by thesis and by project.

This is not to say that theoretical and practical accounts appear in any chronological sequence or determinate relation, as hypotheses and experiments might be in a scientific project. There is no causal or even sequential relation, except for how elements are positioned within the overall argument and organization of the text. Thus, theses and projects do not meet in any tidy way, just as interaction design and architecture might not. Situating relations between, 'Material practice', 'Participatory practice', and 'Critical practice' filter implications of concepts into issues for practice, which act to stitch together the three sections within each of the three themes.

This 3x3 framework sets out a certain diagrammatic form of the text, evident in the vertical and horizontal organization of the table of contents – a form that has also been the ordering principle for the writing process itself. Within this framework, juxtapositions, insertions, and speculations do not resolve, but rather expose and open up certain points of intersection.

Notes

1 For background on these tendencies in technology research and development see Aarts and Marzano, eds., *New Everyday*; Streitz and Nixon, eds., "The Disappearing Computer," *Communications of the ACM*; Weiser, "The Computer for the 21st Century," *Scientific American*.

2 See, for example, Norman, *Invisible Computer*.

3 For some history, current tendencies, and a range of examples see Cameron, *Art of Experimental Interaction Design*; Moggridge, *Designing Interactions*; Philips Design, *Vision of the Future*; Perkins, ed., *Experience*; Saffer, *Designing for Interaction*.

4 For a history and discussion of such topics see Abowd and Mynatt, "Charting Past, Present," *ACM Transactions*; Buxton, "Integrating the Periphery," *Proceedings of Graphics Interface Conference*; Dourish, *Where the Action Is*; Grudin, "The Computer Reaches Out," *Proceedings of CHI*; Ishii, *Tangible Bits: Towards Seamless Interfaces*; Tolmie, Pycock, Diggens, MacLean, and Karsenty, "Unremarkable Computing," *Proceedings of CHI*.

5 For an overview of concerns in HCI and CSCW see, for example, Baecker, Grudin, Buxton, and Greenberg, eds., *Readings in Human-Computer Interaction*; Bagnara and Crampton Smith, eds., *Theories and Practice in Interaction Design*. For discussions of current challenges and possibilities see: Blythe, Overbeeke, Monk, and Wright, eds., *Funology: From Usability to Enjoyment*; Fällman, "In Romance with the Materials" (PhD diss.); Kyffin, Marzano, Thackara, and Dunne, "Experiencing the Disappearing Computer" (transcript); Mavrommati, Munro, and Goulden, "Sustainable 'Disappearing Computer' Artifacts and Spaces," *Proceedings of Tales of the Disappearing Computer*; Redström, "Designing Everyday Computational Things" (PhD diss.).

6 'Things That Think' is the theme of a research consortium at the MIT Media Lab directed by Hiroshi Ishii, Joe Paradiso, and Roz Picard.

7 See Thackara, ed., *Design after Modernism*. In particular see the chapters: Thackara, "Beyond the Object"; Baudrilliard, "The System of Objects"; Chaput, "The Demise of Classical Rationality; "Coates, "Street Signs"; Frampton, "Place-Form and Cultural Identity"; Jones, "Softechnica". See also, Berman, *All That is Solid Melts into Air*.

8 For background see Jameson, *Postmodernism*; Miller, *Material Culture and Mass Consumption*. For some design perspectives see Hays, ed., *Architecture/ Theory/since 1968*; Margolin, ed., *Design Discourse: History, Theory, Criticism*; Margolin and Buchanan, eds., *Idea of Design*.

9 For related arguments and examples see Foster, *Design and Crime*; Hall, *Cultural Representations and Signifying Practices*; Mau, *Life Style*; Seabrook, *Nobrow: The Culture of Marketing*; Vihma, ed., *Design: Pleasure or Responsibility?*.

10 For some examples see Kurvinen, Koskinen, and Battarbee, "Prototyping Social Interaction," *Design Issues*; Redström, "Towards User Design?," *Design Studies*; Routarinne and Redström, "Domestication as Design Intervention," *Proceedings of NORDES*; Svalbo, "Language of Objects and Artifacts," *Proceedings of NORDES*; Verbeek and Kockelkoren, "The Things that Matter," *Design Issues*.

11 For background on relations between sociology, technology, and material culture see, for example, Akrich, "The De-Scription of Technological Objects, in *Shaping Technology/Building Society*, ed. Bijker and Law; Bijker, *Of Bicycles, Bakelites, and Bulbs*; Dant, *Materiality and Society*; Latour, "Where are the Missing Masses?" in *Shaping Technology/Building Society,* ed. Bijker and Law. For some relations between design, art, and material culture see Attfield, *Wild*

Things: The Material Culture; Forty, *Objects of Desire*; Pointon, *History of Art*.
For some relations to HCI and CSCW see, for example, Button, "The Ethnographic Tradition and Design," *Design Studies*; Glimell and Juhlin, eds., "Making a Thing of Things," in *Social Production of Technology*.

12 For related tendencies and some examples in architecture see Allen, *Practice: Architecture, Technique, and Representation*; Hill, ed., *Occupying Architecture*; Kennedy and Grunenberg, *KVA: Material Misuse*; Mori, ed., *Immaterial/ Ultramaterial*; Somol and Whiting, eds., *Log*.
For further 'conceptual' and 'critical' tendencies see Blauvelt, curator and ed., *Strangely Familiar*; Dunne and Raby, *Design Noir*; Robach, curator and ed., *Konceptdesign*; Seago and Dunne, "New Methodologies in Art and Design Research," *Design Issues*. See also, Pels, "The Spirit of the Matter," in *Border Fetishisms*, ed. Spyer.

13 See also Hallnäs and Redström, *Interaction Design: Foundations, Experiments*; Mazé and Redström, "Form and the Computational Object," *Digital Creativity*; Redström, "Designing".

14 For background on post-/modern aesthetic theories see, for example, Harvey, *Condition of Postmodernity*; Kwinter, *Architectures of Time*. For some examples see Rowe, *Design Thinking*.

15 See, for example, Kwinter, *Architectures*; Taylor, *Moment of Complexity*; Simon, *Sciences of the Artificial*; Virilio, *Aesthetics of Disappearance*.

16 'Becoming' is a concept in philosophy explored by Nietzsche, Bergson, and Deleuze, and also by Heidegger, Merleau-Ponty, Foucault, and others. For futher background see Grosz, ed., *Becomings: Explorations in Time*.
The concept 'in the making' introduced by William James has been influential in phenomenological and pragmatist thinking. In design see, for example, Ockman, ed., *Pragmatist Imagination: Think about 'Things in the Making'*.
'Futurity' is an issue in the philosophies of Bergson and Minkowski see Grosz, *Becomings*. For relation to discourses on space and architecture see Grosz, *Architecture from the Outside*.

17 See Conrads, ed., *Programs and Manifestos*; Focillon, *Vie des Formes*; Frampton, *Modern Architecture*; Giedion, *Space, Time and Architecture*; Zevi, *Architecture as Space*.

18 For examples of perspectives on this see Brand, *How Buildings Learn*; Forty, forward to *Strangely Familiar*, ed. Borden, Kerr, Pivaro, and Rendell; Rendell, "Doing it, (Un)Doing it," in *Occupying Architecture*, ed. Hill.

19 See, for example, Foucault, *Discipline and Punish*; Hunt, "Just Re:Do it," in *Strangely Familiar*, ed. Blauvelt; Rossi, *Architecture of the City*.

20 In this text, 'vernacular' is developed as a discussion of typology and the work of Aldo Rossi, celebration of the 'ugly or ordinary' by Robert Venturi, Denise Scott Brown, and Steven Izenour; and Rem Koolhaas' concept of 'Bigness'.
'Event' in architecture is taken as a discussion of Bernard Tschumi's work, Iain Borden's notion of 'performance', and Stan Allen's account of 'infrastructure'.
The term 'non-design' comes from Agrest, "Design versus Non-Design," *Oppositions*; it is developed here in relation to anti-design and Non-Plan movements, and certain works of Peter Eisenman.
Extensive references are in the 'Notes' of sections to follow.

21 For a survey of key issues in design studies see Buchanan and Margolin, eds., *Discovering Design: Explorations in Design Studies*; Margolin, *Politics of the Artificial*; Margolin and Buchanan, eds., *Idea of Design: Design Issues Reader*.
For further discussion of design and the humanities see, for example, Buchanan, "Rhetoric, Humanism, and Design," in *Discovering Design*.
For discussions of relations between design and science see, for example, Dahlbom, Beckman, and Nilsson, *Artifacts and Artificial Science;* Jacques and

Powell, eds., *Design:Science:Method*; Simon, *Sciences*.

22 See, for example, Attfield, *Wild*; Lees-Maffei and Sandino, "Dangerous Liasons"; Sandino, "Here Today, Gone Tomorrow," *Journal of Design History*.

23 For related arguments see Bagnara and Crampton Smith, *Theories*; Seely Brown and Duguid, "Borderline Issues," *Human-Computer Interaction*.

24 See Notes 4 and 6 above. See also Crampton Smith and Tabor, "The Role of the Artist-Designer," in *Bringing Design to Software*, ed. Winograd.

25 See Crampton Smith, "The Art of Interaction," in *Interacting with Virtual Environments*, ed. MacDonald and Vince; Crampton Smith, "Computer-Related Design," *interactions*; Dunne et al., *Design Interactions*; Ehn, "Manifesto for a Digital Bauhaus," *Digital Creativity*; Ehn, "Neither Bauhäusler nor Nerd: Educating the Interaction Designer," *Proceedings of DIS*; Ehn, "Participation in Interaction Design," in *Theories*, ed. Bagnara and Crampton Smith.

26 Common references include Alexander, *Pattern Language*; Alexandar, "A City is Not a Tree," in *Design after Modernism*, ed. Thackara; Mitchell, *City of Bits*; McCullough, *Abstracting Craft*; McCullough, *Digital Ground*. For background on the 'design methods' and 'Participatory Design' movements, refer to the section on 'Participatory practice.'

27 See, for example, the discussion of Peter Eisenman in Thomas Mitchell, *Redefining Designing*; and the perception of architecture in Sanders, "Design Research in 2006," *Design Research Quarterly*.

28 For some possible approaches see Bagnara and Crampton Smith, intro to *Theories*; Buchanan, intro to *Discovering Design*; Buchanan, "Strategies of Inquiry in Design Research," (presentation); Cross, "Designerly Ways of Knowing," *Design Issues*; Hallnäs and Redström, *Interaction Design*; Krippendorff, *Semantic Turn: A New Foundation*; Nelson and Stolterman, *Design Way*.

29 For some background on post-critical and anti-foundational tendencies see Allen, *Practice*; Unger, *Social Theory: Its Situation*.

30 For this and related arguments see Rittel and Weber, "Dilemmas in a General Theory of Planning," *Policy Sciences*; Buchanan, "Wicked Problems in Design Thinking," in *Idea of Design*, ed. Margolin and Buchanan.

31 For various perspectives in this discussion see Cross, ed., *Developments in Design Methodology*; Jones, *Design Methods: 2nd Edition*.

32 For related arguments see Buchanan, "Rhetoric"; Krippendorff, *Semantic*; Nelson and Stolterman, *Design*.

33 See Buchanan, "Rhetoric"; Winkler, "Design Practice and Education," *User-Centered Design*, ed. Frascara; Winkler, "Morality and Myth: The Bauhaus Reassessed," *Looking Closer*, ed. Bierut.

34 Schön, *Reflective Practitioner*, 68. See also Argyris and Schön, "Participatory Action Research," in *Participatory Action Research*, ed. Whyte.

35 See Ehn, *Work-Oriented Design of Computer Artifacts*.

36 For some relevant background on architectural theory see Borden and Rendell, eds., *Intersections: Architectural Histories and Critical Theories*; Hays, ed., *Architecture*. For an overview of 'praxis' see Bernstein, *Praxis and Action*.

37 See Rendell, "Architectural Research and Disciplinarity," *Architecture Research Quarterly*. For some comments on theory in architecture in relation to other fields see Coyne, "Wicked Problems Revisited," *Design Studies*.

38 See Seago and Dunne, "New Methodologies in Art and Design Research," *Design Issues*. See also Dunne, *Hertzian Tales*; Dunne and Raby, *Noir*.

39 Cf. Gaver, "Accountability," in *Presence Project*; Rendell, "Architectural".

40 See Binder and Redström, "Programs, Experiments and Exemplary Design Research," *Proceedings of Wonderground*; Mazé and Redström, "Difficult Forms: Critical Practices of Design and Research," *Proceedings of IADSR*.

41 Frayling, "Research in Art and Design," *Royal College of Art Research Papers*.

Materials

Material life

Human history is bound up with material exploitation – the Stone, Bronze, and Iron Ages are named accordingly. As Marx tells it, materials are the basis of civilization. Even natural deterioration entailed that the machines of the Industrial Revolution were best put to intensive use, speeded up even as 'clocktime' came to regulate all of life, replacing the medieval cyclical time set by agricultural seasons and church bells. Today, materiality is determined less by nature than by the human intervention of the synthetic and artifactual. It has been the task of philosophies of historical materialism and sociologies of material culture to explore the relations among things, people, and societal forms – the complexities of our material life. [1]

The Information Age has brought many related portents. Terms such as im/material, virtual/real, and in/corporeal are often used to characterize the rather profound changes to our material reality underway. Such 'antispatial' tendencies, as William Mitchell dubs them, may be cause for celebration or consternation. For some, it suggests a 'posthuman' dystopia, for others, merely digital analogs to ourselves and our things, as in 'ears/telephony', 'façade/interface', and 'bookstores/bitstores'. [2]

Certainly, the shift from mechanical to information technologies has caused a radical transformation of materiality. Technological objects such as computational devices may be, simultaneously, complex, miniature, and ultra-fast – this breaks with the spatial and temporal scales of mechanical objects, which have tended to correspond in relatively direct, or at least proportional, ways to our human senses and order of magnitude. Further, tendencies towards 'ubiquitous computing' and 'ambient intelligence' infuse information and communication into everyday environments, such that computers and interfaces may disappear altogether. Nanotechnology and molecular electronics mean that any material might become 'active', 'sensitive', and 'smart'. [3]

The concerns and practices of material and information science are overlapping in quite fundamental ways – that is, in the design of the building blocks of our everyday world, from the levels of atoms and bits to those of technological and architectural objects. Thus, we must revise our conceptions of form, in both material and technological terms. As industrial design theorist Ezio Manzini argues,

> If a technical system undergoes a period of rapid change, the need arises to modify the criteria by which one recognizes the artificial. This is the phase we are now experiencing. The transformation of materials, manufacturing processes, and technological knowledge has brought about a new artificial, as well as the entire system of space-time relationships that we base on that artificial. [4]

In this so-called 'new artificial', traditional materials become smart and fast, and technological capabilities may be materialized in almost any form. We can no longer judge by appearances – nor can we merely design surfaces.

In the applied arts and architecture, a shift in focus 'beyond the object' and to the 'space between objects' rethinks spatio-temporal intersections of 'social praxis' with 'spatial syntax' – and the events sparked by interaction between. Such perspectives on 'material life' point to considerations of temporal – rather than merely spatial – form, requiring us to revise our traditional object-oriented approaches to design thinking and making. The following sections discuss such tendencies, traced through perspectives on industrial design, architecture, and material science, through to a notion of what might constitute a 'Material practice' in interaction design.

The logics of machines in the Mechanical Age tended to be rather apparent, proportionate in size to their level of complexity. For example, the mechanical workings of the locomotive, one of the 'instruments of power' celebrated by modernism, visibly transformed fuel into speed via moving parts. However, as John Chris Jones describes, computers are "non-mechanical, depending not on wheels, gears, pistons, rivets, or heat engines, but on electric power, low currents, complex circuits, minute components, invisible processes, relativities (in place of absolute standards), and on finding external analogues and processes fast and delicate enough to be matched to the operations of the eye, the ear, the brain or any other organ of the body." [5]

There are substantial differences between mechanical and computational logics – differences in 'space-time relationships', as Manzini put it. Computation is characterized by increasingly rapid processing and miniaturized components. According to Moore's law, the processing power of computers not only doubles every 18 months, but decreases to half the cost and shrinks to half the size. As J.D. Bolter notes, "The logic of computers is expressed in forces that are averages of the behavior of many electrons. No machine has ever been so far removed from the world of human experience: the largest aircraft carriers are still infinitely closer to the human scale than the simplest, slowest microcomputers." [6] As computers become more complex, how things work may no longer be directly available to ordinary perception.

"Machine monster worry? Then package it!" Archigram once proclaimed. [7] With the 'See-through Sony TV' in 1969, the challenge to modernist dictums of 'form follows function' and 'truth to materials' was rendered literally apparent. Its components were exposed through a Perspex casing but the technical functioning was too complex for anyone but a specialist to understand. Transparency, in a material or phenomenal sense, is reduced to a surface – and superficial – quality. This signaled a shift in which product surface would be treated, instead, as symbolic of other things.

This causes difficulties for relating to technology in conventional terms of materials and form. Jean-François Lyotard, organizer of an influential exhibition called 'The Immaterials' in 1985, suggested, "neither matter not material is what it seems to be, we see nothing directly, outlines and surfaces are human perceptions, not concrete facts." [8] We can no longer hope, as Le Corbusier did, that the exterior of an object is the result of its interior – even the most honest or transparent of materials may not relate to the actual workings of a technological object. Derailing any entirely causal or determinate relation of 'form follows function', the design of technological objects might easily be reduced to 'outlines and surfaces' and 'analogues'.

Post-industrial technologies force us to rethink quite basic conceptions – and design conventions – of materials and form. As Anthony Dunne evocatively describes,

> The electronic object is an object on the threshold of materiality. Although 'dematerialization' has become a common expression in relation to electronic technology, it is difficult to define in relation to the tangle of logic, matter and electrons that is the electronic object. [9]

As an example of a technological object, computers are fundamentally abstract. Certainly, the machine itself consists of physical components such as electronics, which generate patterns of electrical and magnetic activity. However, rather than the 'physical machine', it is these patterns that are central to building complex systems, as they are related and manipulated at various operational levels. For example,

voltages are interpreted in the digital logic of ones and zeros, and change over time as sequences and cycles. The 'abstract machine' then interprets logical patterns into symbols such as numbers and characters, which may be controlled via programs. Such programs may be written in machine or assembly languages, or higher-level languages with textual and graphical representations over groupings of operations.

A computational system, schematically conceived, is essentially comprised of cascading levels of representation. Our typical interactions with such systems take place only at the top levels of representation – the 'user interface' presents us with graphic or other symbols representing functions, which in turn may be broken down into commands, parameters, and arguments, in turn comprised by patterns of digital logics, and so on. When we interact with an interface, we act upon symbols that put into effect a cascading array of complex and abstract operations. In fact, the history of human-computer interaction, as a progression through 'electrical', 'symbolic', 'textual', and today 'graphical' and 'tangible' models, is concerned with improving the top layer of representation over increasingly complex computational operations. [10]

Of course, computational operations continue to be bound up with material reality. This happens at various levels – for example, electronics at the most basic level operate according to the physical laws of nature, and the user interface at the top level relates to our senses and cognition. As Manzini notes, "There is no information without a medium, there is no information processing without single crystal silicon (or, in the future, other materials)." [11] Somehow, from the basic physical machine, computation originates in the material world, and returns to us in ways that are 'sensible' – to our eyes, ears, touch, or other sensory modality.

Materials
Material life
Im/material

Or, materiality might be conceived in terms of familiar product categories – Abraham Moles points out, "Every symphony has its compact disc; every audio experience its loudspeaker; every visual image its camera and video disc." [12] Further, products are made up a range of basic materials – we might be most familiar with the cathode rays, liquid crystals, plasma, glass, and polymers that our camera and computer screens are built out of, though any range of other materials might just as well be used. Similarly, we might typically act upon technological objects by means of plastic buttons, though any range of other materials and forms might be possible. In one way or another, computation must be materialized in order for us to perceive (through displays) or interact with (though interfaces) computational systems.

It is precisely how information, communication, and computation relate to our everyday material life that poses the most challenging questions for design. In recent decades, the appearance of technological objects has been explored and expanded – for example, questions and critique with respect to the relations among modalities, materials, and meanings have been central to industrial design.

"Then package it!"

Perhaps unsurprisingly, given the task of representing how technological objects work, industrial design has become preoccupied with packaging. "Because the mechanical design of electronic objects gives few clues to their operation," Dunne notes, "the problem they posed to most designers soon reduced to one of packaging." [13]

Since neither a Perspex nor a 'black box' suffice to reveal the inner workings of such objects in any direct or meaningful way, other approaches to product surface have developed. For example, 'product semantics' at Cranbrook in the 1980s generated a series of experimental products that were, literally, symbolic icons – Lisa Krohn's answering machine, designed with Tucker Viemeister, was shaped as an address

book. While such products were critiqued as culturally-specific one-liners, the influence of semiotics and semantics continues to resonate – including the now pervasive graphical user interface (GUI) 'desktop' metaphor. Alternatives were explored at the Royal College of Art in London. Durrell Bishop investigated computing 'off the desk'. His 'Marble Answering Machine' from 1992 dispenses balls each time a message is received – an early example of tangible user interfaces (TUI), it moves information out of the computer, to be represented by physical rather than graphical icons. [14]

An expanded graphical and tangible vocabulary may render interactions more intuitive, meaningful, and pleasurable. However, it also adds on 'product languages' – for example, a haptic input language on top of a visual semantic language. While product semantics are effective for objects with relatively simple and familiar functions, mapping complex functions without functional or haptic counterparts in the physical world rapidly becomes complex and even arbitrary. Further, as devices become increasingly complex, smaller, and multifunctional, the problem of fitting and accessing everything via an interface increases as well. Functions that become hard to see or read due to the reduction in product surface similarly become hard to act upon through tangible mechanisms. After all, the number of buttons and balls associated with a particular product are likely to limited, not to mention that they must map back to graphical interfaces themselves restricted by 'screen real estate'. [15]

The widening gap between increasingly complex technological objects and the people that should somehow relate to and interact with them entails increased focus on the surface between – the user interface – whether GUI or TUI. As such interfaces may only relate metaphorically to underlying logical and computational operations, their design may be based on entirely different models and unrelated materials. Indeed, the extension of an originally linguistic system into product design may have the effect of subordinating the physical qualities of things to their word-like properties. [16] If the qualities of objects become subservient to that which they are intended to represent, the qualities of haptics do as well. We return to the real world of action and things – but only via an improved top layer or additional layers on top of the already complex cascading levels of representation in a computational system.

Bishop warns, "Material culture of non electronic objects is a useful measure of what the electronic object must achieve to be worthwhile, but it is important to avoid merely superimposing the familiar physical world on to a new electronic situation, delaying the possibility of new culture through a desperate desire to make it comprehensible." [17] Certainly, the importance of 'packaging' only increases with technological complexity. However, such approaches do not really seem to dig beneath the surface – and skimming the surface might merely reinforce the im/material divide. Technological complexity increases, material complexity increases, our approaches to the surface between proliferate – but deeper connections may not be forged.

Perhaps we need to make further effort to understand the basics, the underlying 'nuts and bolts' or, perhaps more appropriately, 'bits and atoms'. Unfortunately, this is often perceived to be beyond the scope of design. As Dunne notes, "Closing the gap between the scales of electronics and objects by directly manipulating materials as volumes of electrons is a difficult route for designers. This task is essentially limited to scientists." [18] However, examining contemporary discourse and practice reveals a great deal of important experimentation underway among engineers, architects, fine and applied artists. These will be hinted at in following sections and delved into in 'Material practice'. This also indicates implications for how we conceive of materials and form – at nano, micro, and macro scales – so, first, back to basics.

Atoms and bits

For much of human history, there have been relatively few materials. For about the first million years, there were only about five – wood, rock, bone, horn, and leather – which slowly expanded to include clay, wool, plant fibers, and, relatively recently, metals. Today, there are countless possible material combinations, and thus a nearly infinite number of properties that may be produced. Manzini points out that materials may be "'made to order,' with properties that are determined by altering their microstructures (by selecting one or more polymers and appropriate fillers and additives) or macrostructure (by creating composite materials)." [19] This is no longer selection from a stable and standing reserve of material resources – whether 'raw' from nature or from standard industry catalogs – this is design from the molecule out.

Size matters, time counts

With new materials, appearances may deceive. A superpolymer, for example, does not show its properties differently from any of the more common polymers. Micro- and macromechanics have long been applied to compose such materials – linking molecular theory to structural engineering – at scales beneath that of our ordinary threshold of perception. How materials are composed effects chemical synergies, thermal resistance, optical properties, and structural or mechanical capabilities. Layering in active materials, including those that may be activated computationally, enables such effects to be controlled and changed. As Toshiko Mori notes, "We can theoretically produce materials to meet specific performative criteria; this transformation often takes place at the molecular level, where materiality is rendered invisible (such as in nanotechnology). Thus the sea change we sense is subtle and subversive because it is occurring below the surface of visible artifacts." [20]

New materials are not so much characterized by visual or physical appearance, but by the range of new 'performances' that become possible. Typical performances of an ordinary surface might include mechanical properties (for example, durability, ductility, and tactility) and two-dimensional treatments (printed patterns or iconography). With new materials, these expand to include active display (for example, dynamic change in color, luminosity, or heat) and interactivity (materials sensitive to external inputs). Further, nanotechnology can produce building blocks for computational and interactive operations at a molecular scale – a field of development called 'molecular electronics'. A range of such performances may be possible within a single material – a material not visibly different than any other.

A shift from appearance to performance also parallels a shift in focus. Miniaturization signals both the scale at which we might design new materials, as well as the forms that might result. "The term 'miniaturization,' in the current phase, no longer means the production of smaller components: it often signifies the elimination of components as such," Manzini argues. While up to 35% of architectural volume might be given over to heating and ventilation systems today, many space-intensive functions may be eased or replaced by materials with UV-reflection, thermal distribution, and solar collection properties. Thus, he continues, "high-performance materials offer more (performance) with less (quantity of material employed)." [21]

If materials, according to ordinary perception, become less obtrusive or even seem to disappear, this does not mean they become less important. High-performance and multifunctional materials that do 'more' with 'less' enable new possibilities. Form factors may shrink or there may be new forms altogether. This might be compared to the structural and aesthetic revolution of reinforced concrete in architecture. The combination of properties in a single, monolithic material enabled gravity-defying

sculptural effects and the separation of structure from infill – effectively dematerializing building facades. The same forms, or even more expansive ones, could be constructed with less material. 'Miniaturization' and 'dematerialization' are simply two material expressions possible today, among an expanding range of others.

Besides the spatial effects that might be achieved with new materials, a shift from appearance to performance puts time in focus. Of course, time is intrinsic to materials – wear, fatigue, elasticity, and corrosion are all incorporated into our understanding of material properties. In fact, metallurgy long ago forced us to understand even the most traditional of materials in terms of dynamic properties – variable and emergent molecular and chemical behaviors – that is, the inherently self-organizing capabilities of matter and energy in the real world. The natural temporality of materials may even have its own particular value – for instance, as patina and rust have been extensively accounted for in art history and material culture. [22]

With new materials, temporal factors in fabrication may be controlled much more minutely than before. Perhaps the most iconic historical example of this is plastic, which launched rather profound conceptual and structural effects in recent design history. Plastic, more than any other material, is determined by temporal parameters. The properties of this 'fluid-solid', with which anything from packaging and picnic-ware to prosthetics and rockets might be produced, are fundamentally determined by factors of time in the fabrication process, such as alteration of thermal cycles, the curve according to which loads are applied, and the duration of strain. [23]

Today, as traditional and technological systems may be integrated and designed together at the most basic levels, fabrication processes are also changing. Already, the formation of advanced fiber composites, including electronic components, may be a unitary process, wherein composition is determined point-by-point at many levels at once. Indeed, this is a powerful new paradigm for architecture, since one way to save money is to save time – such 'parallelism' effectively shifts the labor structure from a hierarchical or serial mode to a parallel and multi-task mode. This brings the previously separate practices involved in the design of materials, of technology, and of artifacts together, addressing the same issues simultaneously.

Aside from fabrication, perhaps the most profound effect of new materials is enabling performances to occur long after. Any surface or form might involve not only chemical but computational interactions – active and interactive performances that may evolve naturally, by design, or through use over time. As Sheila Kennedy notes, "The dynamics of time can be engaged. The duration of light or information media allows the same surface to be silent and part of the background at times and materially present at other times." [24] With the development of bio-chemical sensors, molecular electronics, and nanotechnology, the performance of such composites may become sensitive, interactive, and even self-generating.

The opportunities and challenges raised for design are vast – far exceeding the need to select and classify materials differently, or to innovate manufacture and fabrication. In addition, it requires that we change our conception of materials in design – beyond that of shaping static appearances to that of conditioning performances in space and time. As Manzini argues, there is "a new generation of objects that – rather than being solidly located in space – tend to flow through time." [25] Based on such a transformation of spatial and temporal factors in contemporary materiality, we might reconsider relations of materials to form and formation.

Technology as material

'Space-time relationships' in material life have transformed since the Mechanical Age. Marc Taylor suggests, "the Information Age should not be conceived in terms of growing abstraction and increased dematerialization, but as the complication of the relation between information and the so-called material conditions of life. As the line between the material and the informational becomes permeable, information processes become considerably more extensive." [26] Rather than impending immateriality, perhaps we should reconsider basic concepts of 'materials' and 'form'.

On one hand, problems arise if we consider the materiality of technological objects only in terms of surface and packaging. Reduced to representations on product surfaces, the material means by which computation is made 'sensible' decreases along with miniaturization of form factors and shrinking 'screen real estate'. As computation disappears into traditional materials and familiar objects, displays and interfaces might be anything and anywhere. Systems of metaphor and signification would have to exist within the material culture from which they were abstracted in the first place, alongside diverse technical, design, and social conditions. To be consistent, a visual or haptic 'product language' would have to become much more pervasive – not just in the technical domain but in others from architecture to textile design, which have different and established ways of thinking about such issues.

On the other hand, materials in and of themselves are increasingly in focus in intersections between computer and materials science. Technological objects such as computers might be considered not only in terms of how the 'physical machine' is instantiated or the 'abstract machine' represented, but in terms how characteristic properties effect material performances. As structural, chemical, and computational properties are integrated at nano-, micro-, and macro-scales, even the most traditional materials might become dynamic. Or, vice versa, we might also wonder what it would mean to consider computation as a material. In such terms, computation and other technologies might be considered in terms of how they build the form of things that are materialized in space and that are dynamic in time.

Such considerations certainly seem to point to the increasing permeability of the 'line between the material and the informational' – in space and over time. As computation disappears into things or and as materials become active in any variety of ways, any delineation not only becomes permeable, but begins to become irrelevant. As Manzini puts it, "The idea of a mute and static border to matter is thus replaced by an idea of the surface as an interface between two ambients, with a role involving an exchange of energy and information between the substances put into contact." [27] The borders of technological objects no longer hold, at least to the extent that they might become packaged in any traditional way. However, thinking of technology in material terms turns us to concepts of form fundamental to many design disciplines.

Indeed, material advances are already challenging conceptions of 'form' in design. An ordinary lightbulb, for example, is built up of glass, metal, and other materials – discrete subcomponents, manufactured separately, and combined by design into a whole form. But an electroluminescent material also emits light – essentially, it also performs as a lightbulb. The nature of such a material is not so much that it is 'something to do something else', as in glass to make a lightbulb, but 'something that does something', in and of itself. Indeed, it is the presence of the material – rather than its transparency or dematerialization – that effects a technological performance. Rather than a material only for giving form to or packaging something else, materials themselves are formed and perform.

A shift from thinking of materials in terms of appearance to those of performance entails a corresponding shift from thinking in terms of 'what it is' or 'what it is usable for' to 'what it does'. Indeed, exactly what kind of thing a piece of film or plastic is may only tell in time. Further, with the integration of electronics at even molecular scales, it becomes possible for alterations in material performance long after design and fabrication. This challenges traditional conceptions of materials as elemental building blocks, available as a standing reserve, for design to select and form complete wholes. Not only do materials themselves perform, but combinations may effect further and ongoing synergies among structural, chemical, computational, and interactive performances – emerging by nature or design, and in use.

Traditionally, questions of 'what is' have often been left to science and engineering, as traditionally charged with discovering, inventing, and producing materials. The subsequent question of 'what it is usable for' is more typically left to design to deal with in terms of application, use, and usability. However, today 'what is' is also a question for design, with issues of use, aesthetics, and composition intertwined with choice and craft over material performances extending from the most microscopic to global scale. Indeed, 'what it does' might be achieved through very different material combinations, which might be recombined or reprogrammed to achieve dramatically different performances, within a design process or long after. [28]

Thus, the space of possibilities around 'what it does' is rapidly expanding. Any range of material compositions might effect a performance such as emitting light; compositions and performances change and evolve in time, through chemical, computational, or human interaction. In this situation, it no longer makes sense to separate issues of materials and technologies, operations and packaging, or form from function, since interactions between, at multiple scales, entail that such factors are intertwined, in space and over time. This is the current 'crisis of materiality' – Kennedy argues: "The whole set of terms that we inherited from modernism is thus completely up for grabs: natural, artificial, culture, technology, materiality, media. These terms are coming together and it makes them very interesting and unstable." [29]

Materials
Material life
Technology as material

With challenges to conventional understandings, we might renew our conception of 'form'. Basic definitions such as "material is what builds the thing; form is the way material builds the thing," as Johan Redström puts it, evade some of problems that are raised in such a 'crisis of materiality'. Arguing that "computational technology is a material since it is used to build certain things, 'computational things', and since computation is essential to the way they appear," Redström and colleagues, including myself, have been exploring various theoretical and practical implications of considering 'computational technology as material for design.' [30] In such terms, we might somehow escape the biases of convention that lead us to separate 'materials' from 'technology' and 'aesthetics' from 'functionality' – suggesting a theoretical and practical foundation that might be common to both technical and design practice.

Considering 'technology as material' resonates with other contemporary enquiries into the presence of technology in design form. For example, Kennedy & Violich excavate the material culture embedded in form, exposing the contradictions in modernist pure and abstract forms that hid a more complex material reality – "Despite this abstraction, or precisely because of it, plugs, ports and other points of contact that interrupt the seamless surface gain a new visibility and importance as materials." [31] Architects Diller + Scofidio reject technology as merely instrumental – "Technologies are not design or fabrication tools, but instead are treated as design materials to be deployed within a project." [32] Such approaches return technology to the terms of materials and form, as another way of approaching the 'crisis of materiality'.

Returning to such basic definitions, material relates to form, and vice versa, in terms of how they determine one another. A material might be given by nature or by design, with any range of chemical, mechanical, or computational properties, but what matters is 'what it does' in building form. Form might be determined by any range of materials, and their individual properties and synergies, but what matters is how they come together to effect performances in space – and over time.

The problem of formalism

'Form' is often disparagingly associated with 'formalism'. Accusations of formalism usually attach to the Modern project in design – its (stereo)typical reification of the ideal, rational, and static object, stripped of all inessential elements and subject to the cause-and-effect of 'form follows function'. Formalist approaches often reject any external source of knowledge, venturing instead on an essentialist quest for 'truth to materials', a rational set of objective design procedures, or an autonomous system of formal knowledge within design. A typical critique of formalism is of "object fixation, zeitgeist worship, physics envy (pseudo science), and stradophobia" [33] – to use the words of Colin Rowe, who embarked on his own cubist, collage, or 'gestalt' version of formalism. Postmodern revisions have opposed the correlation of form with the design of 'hard'-ware, that is, with a reductive, essentialist, and static conception.

It has been a theme in postmodern discourse to move 'beyond the object'. Technologies, conceived in terms of 'soft'-ware process of communication and computation, were no longer as sculptural solids in space. The question of 'form' shifted from one of transparently expressing or sensibly packaging technology (as hardware) to technology (as software), in conceptions of dynamic images, artificial intelligence, or continuous redesign that posed challenges to 'object fixation'. Even practices within the traditionally object-oriented discipline of architecture have shifted – Mori argues, "As new materials are invented and technological advances made, architectural practice has moved from working within the limits of static materials to transforming them into dynamic elements by combining, laminating, casting and weaving." [34]

The problem of formalism indicates a misconception in design discourse. Sanford Kwinter puts it succinctly: "Formalism' – sloppy conflation of the notion of 'form' with that of 'object'." A purely object-oriented notion of form perpetuates static and superficial conceptions, as evident in modernism. Instead, as Kwinter elaborates, "the form problem, from the time of the pre-Socratics to the late 20th century is an almost unbroken concern with the mechanisms of formation, the processes by which discernible patterns come to disassociate themselves from a less finely ordered field." [35] If form is the way material builds a thing, then formation might involve processes within the composition of diverse materials and their performances both in space and over time. This exposes more dynamic conception that might better characterize the 'space-time relationships' in contemporary material life.

Indeed, such an understanding of form holds at multiple scales – including materials, objects, and environments. Processes of formation might be understood to arise at a nano or global scale. As Ron Witte and Sarah Whiting argue, "The formalism of material, for example, includes forms which are concrete, brick, plastic, wood, steel, and glass. These material forms are necessarily deployed through a form of process: raising, pouring, molding, piling, and hanging. The combination of the material and the process results in the forming of space, a formalism of action, program, and inhabitation." [36] Another understanding of form might consider wider conceptions of processes of formation. For example, deconstructivist and neo-Situationist approaches in architecture take temporal conditions, such as notions of 'event' in architecture, to enquire into how forms might be (de)composed – by nature, by design, or in use.

Event architecture

Architecture is not just about the design of objects, but relationships in space and time. It was not always understood to be so – indeed, it was only at the turn of last century that 'space' even became the subject of discourse. Sanford Kwinter describes some contributing factors: "Wireless telegraphy and later the wireless home radio set, the electrification of private homes, streets, and public spaces, the proliferation of telephones and automobiles together gave a new fluidity, and a new consistency to everyday space. What once passed as unqualified or as insubstantial began to take on a new palpability, dense with wires and waves, kinetic and communication flows. It was out of this apprehension of space as a kinetic and substantial plenum that the new plasticity emerged, simultaneously in aesthetics and in the relativity theory that was revolutionizing physics in the years between 1905 and 1916." [37] By 1910, Henri Lefebvre argues, common sense and 'commonplaces' were shattered by the 'abstract space' of imperialism, capitalism, and globalism.

As space came into focus with new scientific and philosophical paradigms, designers began to rethink materiality. For example, Italian Futurism was an early movement in modern art and architecture investigating transience, speed, force, and the 'dynamic plasticity' of 'space-time'. Indeed, there is a rich tradition exploring the 'space between objects' put into focus by science in the first half of the 20th century. Parallel to those developing new technology products and infrastructures, Mies van der Rohe, the Bauhaus, and others realized that objects at all scales might be conceived in relation to one another. Rejecting 'object fixation', others in the second half of the century returned to the space between. Informed by sociology, phenomenology, and structuralism, postmodernists examined the space or life between buildings in terms of interactions between 'spatial syntax' and 'social praxis.' [38]

The dictum 'form follows function' exemplifies efforts by modernists to order increasingly complex and 'abstract space'. The death of 'Functionalism with a capital F', as Reyner Banham put it, entailed a postmodern rethinking of 'program', which, early on, focused on circulatory and organizational schema. While this promoted more social and fluid relations, Lefebvre notes that they nonetheless enforced techniques of separation and communication, attempting to control the explosion of time and space and to bring order to the incoherence between different spheres of life. Against such rigid orders, radical critiques were posed by neo-Situationist and deconstructivist approaches – exploring the antithesis of order, hierarchy, and formalism. For example, those to follow here emphasize the intervention of disorder by design and use – spatial (de)composition over time. [39]

(De)composition

The notion of 'event' in architecture, along with those of 'performance' and 'infrastructure', engage spatial relations in terms of time. Resonating with concepts from literature and film, material science and engineering, phenomenology and social theory, these act as a critique of architecture conceived merely in terms of static objects or determinate compositions. Objects and subjects are reconceived in terms of potentially transformative interactions, or events, that might occur in the 'space' or 'life' between. For example, Bernard Tschumi examines 'spatial syntax' as deconstructed by design and in use. Iain Borden's performative critique of architecture explores spatial reprogramming through (sub)cultural practices. Stan Allen also explores performance, but that of the interpenetrating spatial, technical, and social systems making up infrastructure. Each develops strategies for understanding and designing with respect to spatial and temporal relations – among things and in use.

Event

A generation of architects at the Architectural Association in London in the 1960s turned to literature, film, art, and activism to develop strategies for composing and catalyzing architectural space. Nigel Coates started NATO – Narrative Architecture Today – as a movement and a magazine inspired by punk and camp as much as collage and Situationism. Bernard Tschumi asked, "If writers could manipulate the structure of stories in the same way as they twist vocabulary and grammar, why couldn't architects do the same, organizing the 'programme' in a similarly objective way?" [40] He does not attempt to resolve contemporary heterogeneity but to intensify the loss of certainty and infinite plurality, seeking strategies that were 'both/and' and 'neither/nor'. To confront such notions, he collaborated with Jacques Derrida, the philosopher of deconstruction – "After all, deconstruction is antiform, antihierarchy, antistructure, the opposite of all that architecture stands for." [41]

Tschumi's notion of deconstruction opposed any hierarchical or cause-and-effect of 'form follows function'. He argued that a more dynamic and constantly changing relation exists in reality – "Erecting a barricade (function) in a Paris street (form) is not quite equivalent to being a flâneur (function) in that same street (form). Dining (function) in a university hall (form) is not quite equivalent to reading or swimming in it. Here, all hierarchical relationships between form and function cease to exist." [42] An alternative conception was embodied in his notion of the 'event', which drew theoretically on Michel Foucault's socio-spatial critique, Georges Bataille's 'expérience intérieure', and 'les évenements' of 1968. Between space as it has been designed and as it is used, any range of alternate social, psychic, and political events might take place. As he defines –"Event: an incident, an occurrence; a particular item in a programme. Events can encompass particular uses, singular functions or isolated activites. They include moments of passion, acts of love and the instant of death." [43]

In a series of speculative and built urban projects documented as 'Event Cities', Tschumi sought to replace the 'architecture-object' with 'architecture-event'. He proclaimed: "There is no space without event, no architecture without programme; the meaning of architecture, its social relevance and its formal invention, cannot be dissociated from the events that 'happen' in it." [44] Examining the disjunction between expected form and expected use, the notion of program is addressed through a series of formal strategies for catalyzing activities and unexpected programs, in which multiple and heterogeneous functions substitute for a homogenous and unitary one –

> Crossprogramming: Using a given spatial configuration for a program not intended for it, that is, using a church building for bowling… Reference: crossdressing.
>
> Disprogramming: Combining two or more programs, whereby a required spatial configuration of program A contaminates program B...
>
> Transprogramming: Combining two programs, regardless of their incompatibilities, together with their respective spatial configurations. Reference: planetarium + roller-coaster. [45]

His 'Parc de la Villette', built in Paris in 1985, consists of three independent systems – points, lines, and surfaces – that contaminate one another when superimposed. A grid of red 'folies' anchor and intensify intersections – each is a 10x10x10-meter cube, formally 'decomposed' by lexical permutations, with supplementary functions as park furniture and kiosks. Derrida describes Tschumi as an "Architect-weaver. He plots grids, twining the treads of a chain, his writing holds out a net. A weave always weaves in several directions, several meanings, and beyond meaning." [46]

Performance

Drawing on Situationism and critical theory, Iain Borden and his colleagues have been developing a 'performative critique of architecture'. Rather than accepting a distinction between things as defined by design or by use, Borden takes everything as 'found space', available to be appropriated into personal and social practices. For example, to skateboarder Stacy Peralta, urban surfaces and objects are raw material – "Skaters can exist on the essentials of what is out there. Anything is part of the run. For urban skaters the city is the hardware on their trip." [47] Thus, Borden rejects the possibility of a static order –"Skateboarding as a quantitative set of places and actions (moves, routes, routine, sites) is not only further invested with quantitative measures (size, height, distance, duration, speed) but also with qualitative measures (difficulty, complexity, innovation, surprise) and experiential conditions (noise, texture, sound, flow, touch, rhythm, space-time)." [48] As a particular genre of use, skateboarding is both a highly personal performance and well-established social practice. Reexamining architecture through such a practice shifts focus to a range of actions and sensations that re-order the space and time of the built environment.

Rather than straightforward use, or even abuse, skateboarding evades programmatic categorization since most of the built environment has simply never been designed to accommodate it. The forms of the modernist open city and middle-class suburbia are literally re-appropriated as 'concrete waves'. Found objects are taken in the terms of a different set of logics, an alternative to 'proper' spatial and temporal orders – "For example, a handrail is a highly functional object; both the time and nature of its use are fully programmed. If there is a meaning at all in a handrail, then it is directly related to function: that of safety. The surprise of the skateboarder's reuse of the handrail... turns it into an object of risk... The whole logic of the handrail is turned on its head." [49] Skateboarding is not a matter of living out designed programs but of reprogramming an existing configuration through one's own trajectory and speed.

Skateboarding might be seen as a return to the phenomenal space and time of architecture. For example, the 'carve' technique of gradually riding higher up onto a curved surface reengages the basic physics of the body. As Borden describes, "the higher up they go, the more vertical, the more wall-like that surface becomes. This involves a double-movement – and *movement* is key – of body and architectural surface: initially, there is the sudden compression of the body hitting the bottom curve of the transition, in which the terrain is felt to press back on the skater, translating momentum into a forced acceleration of her/his trajectory up the wall; and at this point the second stage of the movement arrives, tense compression is released, and the skater feels the enclosed concave curvature of the transition give way to vertical flatness, and to a corresponding sense of speed and expansivity of space." [50] Through the physics and sensation of movement, basic spatial conditions are rediscovered – not only the basic 'wall-ness' of the wall, but its limits and extremes.

The occupation of space in skateboarding is phenomenal and ephemeral. Borrowing the notion of 'rhythmanalysis', introduced by Lefebvre to describe the paths and stairways in Mediterranean cities as alternative rhythms of space and time, Borden examines the varied temporal conditions in skating. A 'run' is simultaneously measured as a projected whole (the entirety of sequential moves that may be made) and in micro-seconds and millimeters (the precise texture of skateboard, body and built environment). Altering the pace, rhythms, and sequence of engagement with spatial forms, the basic temporality of the existing environment may be infinitely reconfigured. Not only existing spatial forms but temporal regimes are 'found', explored, and played out – sped up, mixed, and slowed – in lived experience.

Infrastructure

Drawing on the thinking of Tschumi, Diana Agrest, and Peter Eisenman (who are discussed elsewhere in this text), with whom he has studied or worked, Stan Allen has developed his own distinct approach. Shifting away from the inspirations of a previous generation, which oriented towards film, literature, and other media, Allen looks towards the materiality and instrumentality of architecture. But rather than focusing only on objects in themselves, he is interested in relations between. For example, he elaborates on the idea of 'field conditions' by describing the evolution of towns in rural America. Open fields were activated for agriculture and other uses by the extent and intersections among transportation, irrigation, and other services. Thus, open land is already, if invisibly, patterned by existing conventions, ownership, or zoning. Towns emerge and grow, simply elaborating on a pre-existing order. In such conditions, it is evident that the whole is not given at once, either in design or in use.

Thus, Allen investigates infrastructure and logistics as means of conditioning field of possibilities, in which intensities and events might emerge in time. Quoting Foucault, he notes that "architects are not the engineers or technicians of the three great variables: territory, communication and speed" [51] – these are infrastructural problems. His conception of infrastructure is one in which design is not so much about individual objects but a framework of relations between – he continues, arguing, "Its primary modes of operation are: the division, allocation, and construction of surfaces; the provision of services to support future programs; and the establishment of networks for movement, communication, and exchange." [52] Instead of imposing a new order, infrastructure reorders that which exists already, extruding field conditions from existing patterns, catalyzing new links, and regulating flows. Rather than progression towards a predetermined state or rigid hierarchies governing relations between the general and the specific – as might characterize a master plan – the idea is to assemble conditions for local contingency and unexpected future events.

While rather technical and instrumental in conception, his notion of infrastructure depends on the emergence of unexpected effects and synergies, continual disruptions structuring the whole through local events. He draws on engineering to evoke such a notion in action – "Although static in and of themselves, infrastructures organize and manage complex systems of flow, movement, and exchange. Not only do they provide a network of pathways, they also work through systems of locks, gates and valves – a series of checks that control and regulate flow... What seems crucial is the degree of play designed into the system, slots left unoccupied, space left free for unanticipated development." [53] Infrastructures must be anticipatory, fixing certain things such as points of service, access and structure, but establishing unoccupied slots and permeable boundaries. Components, whether built or not, are understood to be only provisionally stable, open to time.

Infrastructure, thus, is a framework for events and narratives to emerge. Objects are not rendered irrelevant but conceived within a larger and continually evolving scheme. Neither are systems enough in themselves – while their composition conditions certain possibilities, accidents, interceptions, and interruptions might be seen to reconfigure and structure the whole. He notes, "By remaining attentive to the detailed conditions that determine the connection of one part to another, by understanding construction as a 'sequence of events', it becomes possible to imagine an architecture that can respond fluidly and sensitively to local difference while maintaining overall stability." [54] Design does not happen 'once and for all' but might continually unfold as a conjunction of local interests, infrastructural potentials, and unexpected eventualities. Allen's infrastructural architect is occupied with "logistics: urbanism without the regrets." [55]

Speculations
How might embedded technologies and ambient intelligence become present in use? Or – when?

How might diverse temporal factors relate, such as natural lifecycles, activity schedules, and order of (inter)actions?

How might new systems leverage off existing patterns of artifacts and activities?

Smart-Its Restaurant

Restaurant was developed within a European research project called Smart-Its, which are small computational devices with multiple sensors, processing, memory, and communication capabilities.*

The concept developed through contextual studies, stakeholders interviews, and ideation workshops with project partners. We created scenarios and a demonstration prototype, in which augmented objects support workflows, customer experience, and service design.

Augmented objects in this proposed smart restaurant monitor and respond to local and ad-hoc changes. Since the technology itself is essentially invisible, the issue is how, where – and when – information is significant and may become present.

Scope
1.5 years, 2001-2003

Smart-Its partners
Lancaster University (UK), ETH Zurich (Switzerland), Interactive Institute (Sweden), University of Karlsruhe (Germany), Viktoria Institute (Sweden), VTT Electronics (Finland)

Project team
Ramia Mazé
Timo Ahonen
Stavros Antifakos
Lalya Gaye
Lars Erik Holmquist
Sara Ljungblad
Peter Ljungstrand
Tobias Skog and
Hanna Landin
Magnus Nilsson
Tobias Rydenhag
(IT University Göteborg)

Scenarios
3 scenarios were developed.

• In the 'oyster auction', self-aware food artifacts keep track of their own quality and lifecycle, updating information on their dynamic packaging.

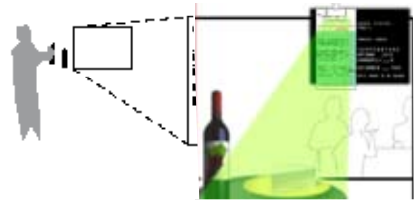
• For a 'dynamic menu', wine bottles keep track of their own treatment and collectively negotiate pricing and recommendation lists.

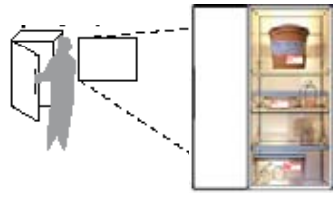
• In 'ready to be served', the actions of kitchen staff and data from customer orders are combined, instantly updating work orders and inventories.

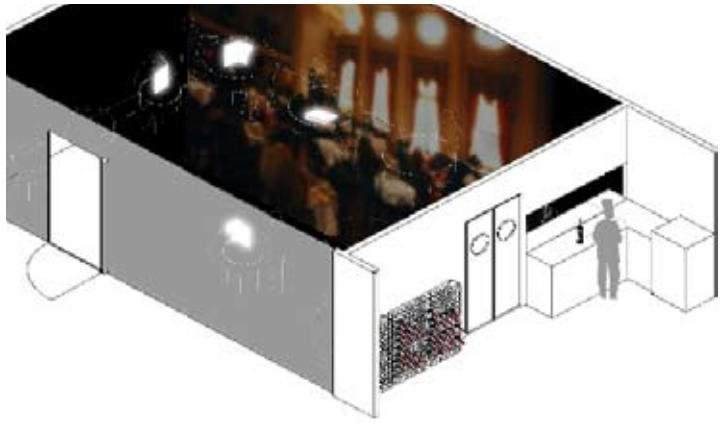
Proposal
Of the 3 scenarios, 1 was produced as a working prototype. We augmented a serving tray, a refrigerator, a piece of cheese, an oyster box, and 2 wine bottles with Smart-Its. 'Percepts' interpreted raw sensor data into useful information, such as ad-hoc groupings or un-groupings of objects in space and quality based on discrete or collective sensor values over time.

In the demonstration, people could interact with the augmented objects – for example, taking the cheese out of the fridge or combining the wine and cheese on the serving tray to complete an order. In response, simple versions of the percepts triggered an animation explaining the scenario and potential product interfaces, displayed behind as a projected animation.

In smart environments, the amount of data is enormous. To locate significant points of intervention between systems of smart objects and human lifeworlds, we focused on events – such as instances of conjunction among discrete data flows, historical or collective patterns of information, and triggers for more specific queries. Thus, events between augmented objects and sensed actions weave the systems into meaningful user experiences over time.







Programming abstract space

Architectural 'program' is one typical way of relating to the space within and between buildings. John Summerson set out an early definition of program as "the description of the spatial dimensions, spatial relationships, and other physical conditions required for the convenient performance of specific functions." [56] 'Functions' might typically consist of a set of required utilities and physical conditions, based on expected occurrences derived from social behavior, habit, or custom. However, notions of 'event', 'performance', and 'infrastructure' challenge any entirely determinate account of form or function. Tschumi argues, "In today's world where railway stations become museums and churches become nightclubs, we must come to terms with the complete interchangeability of form and function, the loss of traditional or canonical cause-and-effect relationships sanctified by modernism. Function does not follow form, form does not follow function, or fiction for that matter." [57]

For theorists in the 1960s, "a truly scientific program for architecture would take in all aspects previously left to tradition, including the aesthetics of perception, human response (visual, psychological, biological), technologies of the environment, and the like; science would simple reveal and propose the best solutions to the design of shelter." [58] Against such conceptions, a 'programmatic revolution' was launched by practitioners from Archigram to Rem Koolhaas, challenging both historicist and positivist conceptions of what might be analyzed, applied, and determined by architecture in the 'production of space'. As Tschumi proposes, "To discuss the idea of programme today by no means implies a return to notions of function versus form, to cause-and-effect relationships between programme and type or some new version of utopian positivism. On the contrary, it opens a field of research where spaces are finally confronted with what happens in them." [59]

Drawing on Situationism, structuralism, and phenomenology, architects explored the construction of meaning – and space itself – by the 'interpreting reader' or 'social praxis'. Narrative and performance, via NATO and Borden, focus particularly on (re)appropriation. Arguing that "empty of cars, car-parks have only form and no function," Borden conceives of the built environment as 'found space', with function only defined as things are taken up into phenomenal encounters and everyday occupations. [60] Rather than 'lived obedience' to 'multifarious and overlapping instructions', as Lefebvre puts it, use becomes itself a mode of production, or opposition. While Robert Stern might issue dismissals – "Even the pipe railings of the 1920s are by now, for most of us, cut off from everyday reference; who among us has been on an ocean liner in the last twenty-five years?" [61] – it is precisely the iconic modernist handrail that is daily reprogrammed by skateboarders as an 'object of risk'.

Adrian Forty once remarked, "the moment in history when the building was finished... is the very point at which the historian's work should begin... architecture, like all other cultural objects, is not made just once, but is made and remade over and over again each time it is represented through another medium, each time its surroundings change, each time different people experience it." [62] Borden argues, thus, that architecture has no innate or fixed meanings. Objects in the city operate, literally, as the building blocks or basic hardware for the skater's run – every 'thing' becomes material for reinterpretation and even 'remaking' in practices of use.

Interplay and afterlife

While designed things and intended functions might be subject to what happens in actual use, this does not reduce the importance of the built environment. Tschumi asks, "can use and misuse of architectural space lead to new architecture?" [63] Borden argues for the practical role of architecture in providing 'hardware' for skating,

but also for the ideological reappropriation bound up with transgressing norms. Even as the built environment is necessary for use to happen in the first place, program is affirmed (or not) by use. Practices of use constitute a "new spatial event, an occupied and occupying architecture. Architecture is at once erased and reborn in the phenomenal act." [64] Use inevitably, even necessarily, reprograms found space with new functions and meanings.

While the ideologically-charged locales of modernist open-plan plazas and suburban private pools might be 'erased and reborn' through deliberate misuse by skaters, the interaction between design and use is ordinarily more complex, as multiple programmatic strategies and diverse practices of use intersect in a common space. While making use of deconstruction, Tschumi does not take it to its logical extreme, which would be "silence, a final nihilistic statement that might provide modern architectural history with its ultimate punchline, its self-annihilation." [65] Instead of erasure or annihilation, Tschumi builds – for use – in order to destabilize any singular meaning or deterministic function. Arguing that any given programme can be analyzed and deconstructed, and then infinitely reconstructed, Tschumi takes the spatial and functional ingredients of any program and mixes them up in a 'madness of asemantics'. Cross-, dis-, and transprogramming become strategies for formal composition that simultaneously destabilize conventions of design and of use.

Materials
Material life
Event architecture

Between things as they are designed and as they are used, program, then, might be considered as an evolving construct. Rather than either annihilation or 'total design', Tschumi seeks out the 'erotic interplay' between. Rather than imposed from the top down, as prohibitive rules or programmatic norms, or arising bottom-up from practices of use, events might be sparked between, catalyzed by the superimposition of multiple systems of formal logic that disorient and proliferate conventional interpretations. Tschumi aims to intensify the 'order-bondage' of the design-use relation to the breaking point of functionality or meaning. Neither design nor use, means nor ends, constitute an 'event' as such – rather, it is the irruption of the unexpected between – "pole-vaulting in the chapel… skydiving in the elevator shaft?" [66]

Allen, like Tschumi, aims to 'construct the site itself', making way for events and performances yet-to-be. He focuses more explicitly on how an architectural and urban composition might perform or evolve over time. Performance, as Allen develops it, does not operate in opposition – adhering neither to modernist shock tactics nor programmatic transgression. Rather than focusing on meaning or objects, the performance of an infrastructure depends on the calibration of 'field-field' relations in terms of energy, force, and resistance.

Although static in and of themselves, infrastructures organize and manage complex systems of flow, movement, and exchange – of energy, services, and information as well as of people. He argues, "Infrastructures tend to be hierarchical and tree-like. However, there are effects of scale (a capillary effect when the elements get very numerous and very small) and effects of synergy (when systems overlap and interchange), both of which tend to produce field conditions that disrupt the overall tendency of infrastructural systems to organize themselves in linear fashion." [67] Instead of specific design proposals for future occupation of a site, infrastructure is characterized, even structured, by local, unexpected, and disruptive effects.

Formation in time

Performance, taken in subjective and phenomenal terms, establishes a temporal order. Such a performance consists of what happens between one point in space and another – that is, the things, incidents, and actions along the way. Thus, each run of a

skateboarder might be characterized by: moves, routes, sites; size, height, distance, duration, speed, and; noise, texture, sound, touch, rhythm. Built up in micro-seconds and millimeters, such factors are experienced as sequences that are both linear and cumulative, gathered into a whole by lived experience and within memory. To the extent that an individual's performance is taken as a primary frame of reference, its unique order of time distinguishes it from those of any other. Placed in opposition to other official modes of spatial production, time and space are entirely subjective. Indeed, architecture and infrastructure become merely backdrops, the 'wall-ness' of walls (subjectively) returned by testing the limits of gravity, the empty parking lot (temporarily) returned to meaningful function by action.

In contrast, any architectural or infrastructural order might seem generic and static. However, Allen's conception of 'performance' in infrastructure is dynamic, though not concerned with meaning, or even with individuals and objects. Infrastructures must accommodate any number of discrete performances, top-down and bottom-up orders, evolving by means of unexpected events and their aftermath. They must be flexible, evolving, and anticipatory – "They work with time and are open to change." [68] Thus, the performance of an infrastructure deals with 'field conditions', gradients of intensity and difference, overlaps and interchanges, exchange and evolution. Slack is designed into the system and slots left unoccupied, left free for the unexpected.

Just as the composition of an individual's performance has its own temporal order, the built environment is a composite of diverse elements, each with spatial and temporal characteristics and relations. The purpose of Tschumi's "tripartite mode of notation (events, movements, spaces) is to introduce the order of experience, the order of time – moments, intervals, sequences, for all inevitably intervene." [69] Resisting any singular, static, or official order, both things and the use of things are understood to be dynamic and evolving. Similarly, Allen notes that an overall stability might be maintained as infrastructures respond fluidly to local difference, construction itself as an ongoing 'sequence of events'. Thus, any particular part of a composition depends upon and determines the other, both spatially and over time. Tschumi continues, "The associations so formed, allow for a plurality of interpretations. Each part is thus complete and incomplete. And each part is a statement against indeterminacy." [70]

Where subjective and (sub)cultural practices produce effects locally, infrastructure scales up effects to those of 'territory, communication, and speed'. However, such a notion of infrastructure is not to be confused with early notions of a 'scientific program for architecture' – at least in the sense of determinism and discipline over natural phenomena and human relations, which provoked neo-Situationist and other opposition in the first place. The 1960s impulse to 'design the conditions' rather than to 'condition the design', resonates with Allen's statement, "Infrastructure prepares the ground for future building and creates the conditions for future events." [71] Carefully incorporating indeterminacy and 'incompleteness', dependant upon unforeseen events and sequences of experience yet-to-be, the spatial order in notions of 'event' is intentionally left open to time – a 'future present' invested in present form.

Temporal form

Rather than attempt to stabilize functions or meanings, 'event', 'performance', and 'infrastructure' delve into the complex interplay of conditions that intersect in the composition of form. Tschumi is interested in destabilizing any determinate meaning of architecture and conventional experiences of use. 'Cross'-, 'dis'-, and 'trans-programming' do not fix conditions or contain all eventualities – instead, a plurality of overlapping programmatic possibilities provoke reinterpretation and new action. Indeed, Borden argues that any range of phenomenal, psychic, or cultural forms of occupation inevitably – and perhaps deliberately – reinterpret original design intentions. Similarly, Allen does not presume any ideal form of design or use. Extruding from pre-existing conditions of a site and occupation, infrastructures evolve by means of ongoing interactions among diverse systems and activities.

Challenging the determinism of form/function, these approaches complicate the 'program' between. Design is not conceived as giving order to abstract space – indeed, deconstructivist and neo-Situationist tendencies disorder fixed or static constructs. Proponents examine, on one hand, how form might be erased, transgressed, or transformed, on the other hand, how design might condition possibilities for programmatic interactions and for future eventualities. For example, R.E. Somol describes Allen's approach as a "more performative role where architecture acts as a medium for the continuous horizontal exchange between natural and artificial ecologies, internal and external activities." [72] Such approaches challenge 'object fixation' in architecture, since focus is on how spatial relations evolve or are transformed over time, whether by natural forces or cultural practices, by design or by use.

Form might thus be understood in terms of ongoing processes of composition – or, indeed, decomposition. While certain material conditions might be in place, even as unoccupied slots, programs proliferate and evolve, events reprogram and transform spaces – and these restructure the potential field of possibilities both in space and over time. This is not, however, to pit a static conception of space against the inexorable progress of time, but to emphasize the interplay of relations between. Sanford Kwinter is careful to point out that: "It is not a question of opposing, according to the familiar neo-classical formula, a spatial to a temporal order, form or regime, but rather, to oppose two different complex orders in which the same elements – spatial and temporal – are constellated in a different way to form separate aggregates with different regimes of effect." [73] Form as (de)composition exposes formation as an ongoing process, structured by any range of more or less determining and interacting forces.

Alternatives to formalism, such as those posed by 'event architecture', expand possible conceptions of form. This opens up for a diversity of spatial and temporal relations – for example, in phenomenal and material performances, in sequences of events and infrastructural evolution. Indeed, such formal (de)composition – from the scale of micro-seconds and millimeters to that of speed and territory – suggests architectural form, as Guy Debord, a founder of Situationism, might describe as a "restless becoming in the progression of time." [74] From the architectural discussion, we might understand the potential scope for conceiving of functions and aesthetics not in the fixed and static terms of formalism, but in terms of formation in space and time.

Just as we might understand an architectural object, and the space between objects, as comprised of things that evolve, interact, and change, so we might conceive of the form of other complex objects. For example, the form of technological objects, as comprised by any range of mechanical, chemical, and computational performances, may change in rather profound ways over time. Indeed, the materiality of such

objects poses rather particular challenges to fixed or static conceptions of form, for example as resonates in traditional notions of product surface, material appearance, and object fixation. Computation renders things active and interactive from the imperceptible scale of smart materials and nanotechnology to fast and global systems of networked objects. Thus, considering 'technology as material' suggests other possible relations to form, for example in terms of (de)composition in time.

'Forms-in-space-and-time'

In considering technology as a material in building form, naturally it becomes important to recognize its particular properties. Just as in all things, technological objects involve spatial and temporal relations. Fundamentally, of course, all things are built from relations among particles, vibrations, waves, and intensities, spatial and temporal structures determining composition at the most basic levels. A theoretical perspective may conceive of a computer purely in terms of electrical impulses traveling through a network of electronic elements. However, there are quite profound differences between 'bits' and 'atoms', though they must somehow be understood and treated together in the design of technological things such as computers.

Even the most complex of traditional materials are thoroughly bound to their physical properties – mechanical, chemical, and so on – and are thus profoundly determined by physics and the laws of nature. Similarly, at the most basic level, computation depends upon electronics that operate according to physical laws. Additionally, to the extent that computational operations must be perceptible, it must somehow be materialized. Between the physical and electronic machine, and displays and interfaces, however, a range of processes are underway that adhere less to physical laws than to a fundamentally abstract realm of digital logics and computer programs. While originating and returning to our familiar material reality, it is precisely these that contribute to the new realm of effects made possible by computation.

Indeed, it might be said that computation is fundamentally temporal in nature. Even the basic elements determining the functionality of computation – lines of code that are executed sequentially, and commands or inputs or actions that are processed and transformed into outputs or reactions – unfold and extend over time. Most computers may be described in terms of a single sequential processor, which executes a program step-by-step. Even as processing power increases, form factors shrink. Considering such tendencies, along with the particularly abstract and logical operations that constitute computation, the properties of computation as material might be conceived in primarily temporal, rather than spatial, terms.

Besides the linear and sequential temporality of programs, computers have other temporal effects. For one thing, computers undergo continuous structural change – unlike the dynamic changes of mechanical objects, such as moving parts, which leave the basic structure constant. Each of the levels making up a computational system has characteristic patterns of behavior – the layered nature of the computer entails that there may be little correspondence between operations at distant levels. As these levels may be affected in various ways, the computer continues to be altered structurally. Every time a program is run, a file written, or a new program added, the system undergoes a change that may cause it to act differently in the future. [75]

Secondly, the layered structure of computers entails that patterns and cycles of logical activity underway at various levels may intersect, reproduce, and evolve in multiple as well as unpredictable ways. The increasing distribution of computation – as integrated into material composites or embedded in familiar objects – introduces further effects. Systems of computational things may be actively connected together

in local networks or across long distances. Such a system is characterized not only by the temporal factors in the composition of each object, to local conditions of context, use, and memory, as well as by the composition of other objects and by the temporality of relations within the system of objects itself.

Thirdly, even as the composition and operation of computational things might be described in temporal terms, so might the new spatial effects enabled. To the extent that the information and communication that computation facilitates refer to the real world and human experience, computational operations must be materialized in some way. For John Maeda, miniaturization has two implications – for the designer, there is a dramatic reduction in the space available for expression, and, for the user, it is no longer possible to judge the object by its exterior. Thus, he argues, "The contemporary solution to the reduction in design volume has been to compensate for physical space with virtual space... Hence, although we might consider an object restricted in a spatial sense, its dynamic surfaces allow the object to transcend those restrictions through expression along the never-ending dimension of time." [76]

An expanded range of formal expressions – in space and time – become possible as any material might become continually active, sensitive, and interactive. While computational technology might take up less space, it entails another trade-off – that of 'information versus time'. [77] As 'more' can be done with 'less' and information materialization may extend over time, it may extend into use – for example as scrolling and selecting from hierarchical menus in graphical user interfaces. Interactivity puts real-time control over computational operations and materialization into users hands. Thus, in addition to the composition of technological objects in themselves, the temporality of embodied and situated interaction also comes into play, introducing a range of issues that are more extensively treated here in the sections on 'Use'.

Materials
Material life
Temporal form

A significant consequence of 'digitalization' that has been discussed is the reversibility and replicability of computational operations. Colin Beardon and his colleagues note the 'save' and 'undo' functions of computer-based tools that diverge from traditional material practices in the fine and applied arts. Malcolm McCullough points out the quantification that takes place during the transformation of electrical phenomena into digital logics, such that configurations and sequences may be reconstructed and previous states stored and recalled. In this process, the natural deviations characteristic of the physical world get rounded and corrected – thus 'bits' achieve a stable state such that they never degrade, but instead may be reproduced ad infinitum. Certainly, as computational complexity is distinguished instead by patterns and cycles of logical activity, such new functions and qualities come into effect. [78]

However, technological objects are composite – a tangle of 'logic, matter, and electrons', as Dunne puts it. To the extent that the complexity of a technological object is due not just to digital logics but also to those of complex materials and physical systems, effects of reversability and replicability are mixed with those of synergy and emergence – those subject to 'the arrow of time', a concept introduced long ago by Arthur Eddington to describe complex systems in physics, biology, and chemistry. Indeed, stating, "Complexity is the science of the materialism – or the materialization – of time," Kwinter discusses the particular effects of complex materials and physical systems, arguing that "their materiality quite simply is not manifested in space but rather in time." [79] This constitutes a fourth temporal aspect of technological objects, as crossovers of any number of material, mechanical, and computational systems.

Advances in computer and materials science fundamentally challenge our established understandings of 'space-time relationships', to borrow Manzini's turn of phrase,

Speculations

How might natural cycles of seasonal and 24-hour change be incorporated into form?

How to create strong impact and poetic effects with simple, robust materials and mechanisms?

What might the balance be between play and action, respite and relaxation?

How might individual, group, and collective behaviors be reflected – how might change in behavior be catalyzed?

Kinetic Shadows

Kinetic Shadows was a winning entry into a competition sponsored by the Organizing Committee of the Athens 2004 Olympic Games. Within the overall theme, 'Catch the Light', the intention was to extend the vitality of the games into the everyday urban arena.

We proposed interactive public furniture that reflects local activity and attracts attention from a distance. Sculptural elements rise from benches to perform overhead. Moving in response to the presence and participation of pedestrians, shadows are cast to shelter moments of respite during the day and lit to illuminate nightlife. An attraction from afar and a catalyst for local social interaction, spectators become players as they engage with the phases of Kinetic Shadows.

Because of delays in the decision-making process, the project was not realized due to lack of time.

Scope
2 months, 2004

Project team
Margot Jacobs
Ramia Mazé
Tobi Schneidler
Adam Somlai-Fischer

Process
The competition was taken in 3 stages: vision pitch, concept on site, technical and economic feasibility.

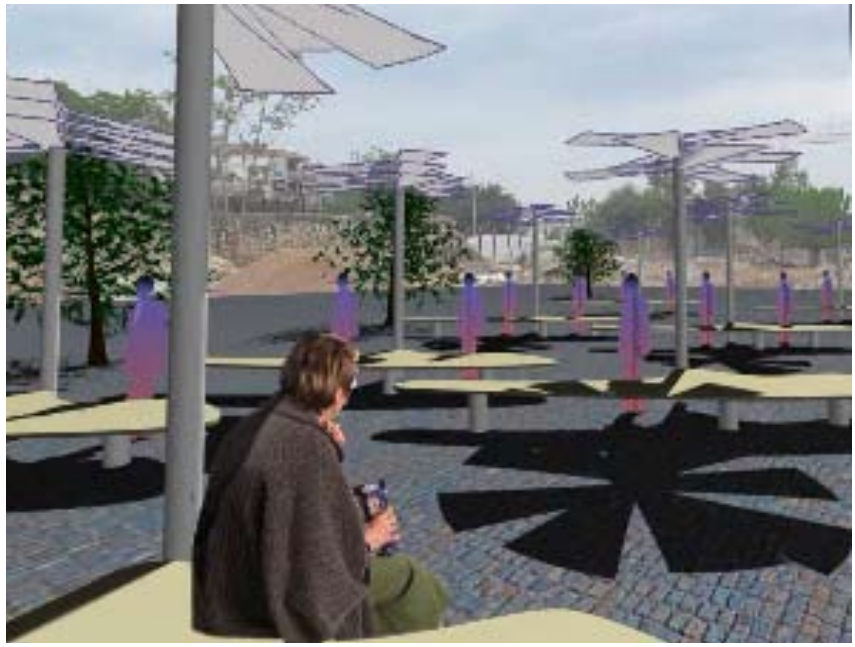
Our concept was based on: principles of engagement at local, group, and mass scales; combination of interactive, natural, and social behaviors, and; continual variation throughout night and day.

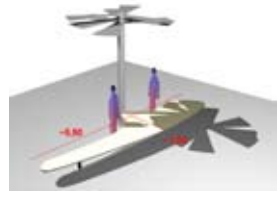
Our site was just beneath the Parthenon, an area under construction at the time. In order to incorporate natural and pedestrian conditions off-site, we built software simulations of sun and shadow behaviors and full-scale, low-fidelity mockups.

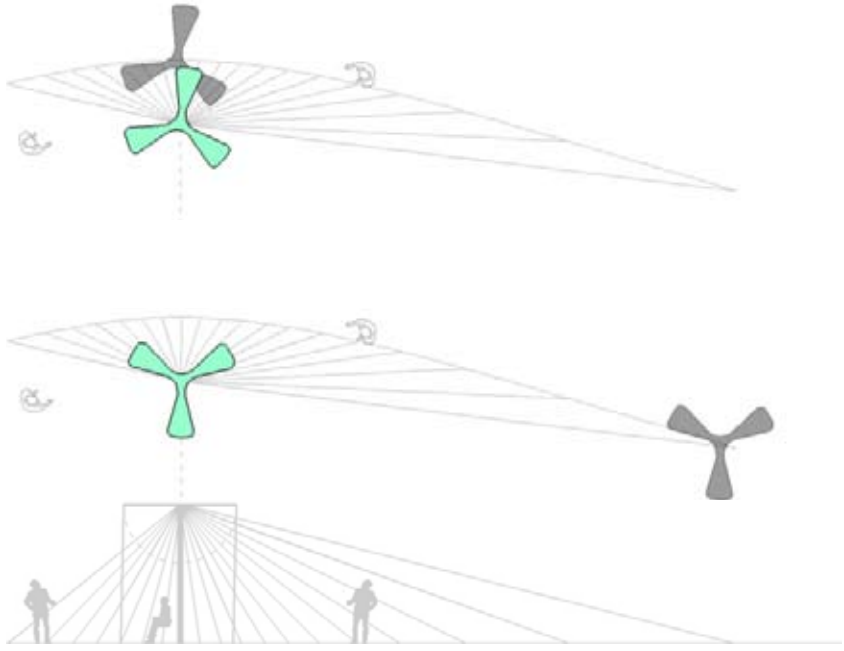
Proposal
The final design proposal consisted of 5-15 public benches to be distributed throughout the site. Rising above each bench to occupy and animate the sky overhead is an electromechanically-controlled shading device.

The shadows lengthen with the sun's passage during the day – at night, inbuilt illumination casts refracted light on the ground. Thus, interactive light/shadow patterns create pools of cool shadow during the day and reverse the effect to highlight nightlife. The pieces are both functional and festive, expressing the celebratory spirit of the games and of urban dynamics.

Proportions of the pieces and their distribution through the site are oriented to seasonal and 24-hour sun cycles. Each object would automatically sense and move in response to local activity, expressing such activity as shadows that might catalyze new activity. Interactive kinetics amplify local use and attract attention from afar – reflections and catalysts of social (inter)action.







requiring us to rethink basic conceptions in design. New technologies present the basis for developing new functional and aesthetic possibilities, but also a need to reconsider the focus and scope of design concern. In this discussion, computational technologies – as well as some implications of nano- and biotechnology – have been explored, since its particular properties challenge established conceptions of space, surface, and form. As computation disappears into things and materials become active, any 'line' between the material and the informational not only becomes more permeable – indeed, any delineation conceived only as spatial form or product surface seems insufficient to describe or develop the design possibilities.

If it was once hard for designers to conceive of 'closing the gap' between the scales of electronics and objects, as Dunne put it, now it is not only possible but necessary to find ways of approaching this, conceptually and in practice. Indeed, the increasing accessibility and availability of technologies has entailed a wide distribution outside science and rapid incorporation by practitioners from diverse fields into new material expressions. Redström notes, "Perhaps we cannot physically shape computational things with our hands the way we shape wood, glass or concrete. But this is not only a question of the properties of matter, perceivable or not, but of what frame of reference we might use, and what questions we ask as we engage in design." [80]

It is not so much the abstraction of technologies at stake, but how technology as material might be understood to challenge conceptions of form and practices of formation. The separation of concerns between the (engineering) design of the electronic, mechanical, and physical properties and that of the (product) design of surfaces and interfaces overlap and blur. Shifting from appearance to performance, functional and aesthetic concerns do not stop at composition or fabrication, but (interaction) design must consider the ongoing dynamics of material behaviors and use. We must reconsider not just how to design – which will be further discussed in the section on 'Material practice' – but also what to design at all.

Computation requires us to rethink materialization not only in spatial terms, but in time. Rather than preoccupation with 'spatial form', we might consider 'temporal form'. This is not to oppose a spatial to a temporal order, to reaffirm Kwinter's point discussed above, but to draw attention to the complex interrelations between. For example, technological objects involve a complex interpenetration of 'space-time relationships' – within materials, objects, human-computer interactions, and systems of objects – impacting how, where, and when temporal conditions and effects might be materialized. Any simplistic dichotemy would merely gloss over the complexity of our material reality, in which traditional and new materials, mechanical and computational technologies, intertwine at nano, micro, macro, – and global – scales.

Within design discourse, certain related temporal concepts have been explored that challenge the primacy of appearance and representation, spatiality and stability. For example, industrial design might also include 'objects that – rather than being solidly located in space – tend to flow through time', as Manzini argues. Jones proposes that design deal with 'forms-in-space-and-time', to relate to the 'time arts' of music, dance, theatre, and literature. Cheryl Akner Koler, Monica Billger, and Catharina Dyrssen consider process-based aesthetics and embodied 'gestalt' to account for working with complex material events. In developing a theoretical approach to the aesthetics of computational things, Redström has explored 'time'- or 'temporal gestalt', for example to describe certain commonalities between the experience of the performance of a music composition and the execution of a computer program. Similarly, Jonas Löwgren and Erik Stolterman raise a notion of 'dynamic gestalt'. [81]

In the discussion here, however, the term 'gestalt' is not entirely suitable. 'Gestalt' typically implies a unified perception or comprehensive emergence – indeed, the classic example from its origins in psychology is that of the holistic formation of a soap bubble, a metaphor also found in Le Corbusier's modernist manifestos. Certainly it may be relevant to describe the overall spatial and temporal character of a particular design conception or subjective experience. However, to the extent that technological objects involve crossovers of multiple and complex material systems, they may be characterized by any number of temporal conceptions and experiences. Indeed, with interactivity, the form of a technological object is determined not just by design, but by interactions in use, involving a range factors that may be more or less anticipated by design. Related to such (de)composition of form, notions of the 'event', 'performance', and 'infrastructure' in architecture problematize any singular, ideal, or comprehensive design program.

'Form', instead, draws attention more specifically to 'how material builds a thing'. How, in this sense, might refer to how something is composed by design or how a design might unfold in use, which may be more – or less – the same thing. Equally, it might describe the spatial or temporal performance of something, whether or not spatial and temporal factors are related in any unified or comprehensive way by means of design or subjective experience. In order to expand a conception beyond 'computation' to the more complex and mixed material conditions of 'technology as material', we might shift instead to notion of 'temporal form'. [82] In the context of the discussion here, such a term better accommodates evolution and emergence as well as the indeterminacy and disruption that might characterize phenomena such as 'events'. Temporal form does not circumscribe or even predict, but describes how some 'thing' comes to be – or becomes – out of various material conditions.

Materials
Material practice
Temporal form

Becoming

In more philosophical discourse, a notion of 'becoming' has been developed with some relevance to the discussion here. Elizabeth Grosz articulates our human impulse to stabilize and objectify the complex and uncertain conditions in our material life – "We stabilize masses, particles large and small, out of vibrations, waves, intensities, so we can act upon and within them, rendering the mobile and the multiple provisionally unified and singular, framing the real through things as objects for us." However, any 'thing' can never be entirely static or contained, since spatiality is bound up with temporality. Grosz continues, arguing, "The thing is positioned or located in space only because time is implicated, only because the thing is the dramatic slowing down of the movements, the atomic and molecular vibrations, that frame, contextualize, and merge with and as the thing." [83] One way of conceiving the relation between space and time in terms that are neither categorical nor causal is in terms of a continuum between – time is fundamental to how things come into being, to their formation, (de)composition, or continual process of becoming.

The urge to analyze, quantify, and fix the complexity of reality into stable forms and formulas prompted the philosopher Henri Bergson to argue that science has never been able to grasp the reality of time itself – as made up of multiple events and becomings, latency, singularities, unpredictable eruptions, transmutations, or evolutions. Temporal conditions posed in terms of the exception or the exceptional is precisely what enables conceptions of the 'event' to escape the 'order/bondage', to borrow Tschumi's phrase, of entirely determinate or causal accounts in dichotomies such as form/function or design/use. As Grosz describes, "An event occurs only once: it has its own characteristics, which will never occur again, even in repetition. But it occurs alongside of, simultaneous with, many other events, whose rhythms are also specific and unique." [84] An event is sparked at the intersection of multiple

processes of becoming, as natural, technical, and social systems interact.

It is precisely the event that draws attention to the impossibility – indeed, undesirability – of control or containment over processes of becoming. While we might 'design the conditions' or 'prepare the ground for future events', to echo Tschumi and Allen, events are precisely that which cannot be predicted, controlled, or designed. Looking to the use of the term by Heidegger and Foucault reveals an important distinction from an 'occurrence', which might more generally refer to a specific presentation or rote performance of something already existing or expected. Unlike the performance of a musical score or the execution of a computer program, an event arises from an unexpected intersection. As Andrew Benjamin points out, "The event has an afterlife." [85] Not only are events nonrecurrent, unrepeatable, and uncontainable, they fundamentally restructure and redirect what comes after.

While formalist conceptions in Modernism strove for an ideal and eternal – even static or total – order, postmodern conceptions celebrate instead the dynamic, emergent, and even divergent. Deconstructivists tended to conceive of the event as characterized by the 'untimely', to borrow Neitzsche's term – that is, the catastrophic, singular, originless, and unexpected. It is precisely such qualities of time that characterize the interactions between 'spatial syntax' and 'social praxis' – the revolutionary impulses of 'les évenements' of 1968 that inspired neo-Situationist architects. Countering notions that the 'production of space' belongs to the proper domain of architecture, such that use might merely involve 'lived obedience', such architectural tendencies investigate use, misuse, and even abuse as an ongoing process of production, remaking, and deconstruction, itself 'making a new architecture'.

Within philosophy, the event occasions two rather different types of theories. A more classical model maintains an opposition of space and time, with the event as a means of transcendence. This resonates in modernist design discourse – and reactionary postmodern attempts – to revolt against or create something independent of any preceding or official order. In contrast, contemporary thinking tends to understand events and other exceptional phenomena as immanent to phenomena, a necessary capacity to make possible or introduce variation, diversity, and change from within. This is perhaps more evident in Riemannian, Einsteinian, and Minkowskian notions of events as intensifying, weaving, or structuring field relations.

This contextualizes another alternative to trying to contain or control the complexity of intersecting forces and systems, by means of analysis, digitalization, theorems – or by means of "all spatial models that today arguably have fallen into disuse." [86] In a more performative or infrastructural sense, the design of temporal form might instead create the conditions for possible events and local interactions. Design might involve siting specific and local points along the deployment, unfolding, or becoming of diverse and intertwined systems.

Notes

1 For background to such topics in the philosophy of science and material culture see: Dant, *Materiality and Society*; DeLanda, "Material Complexity," in *Digital Tectonics*, ed. Leach, Turnball, and Williams; Simon, *Sciences of the Artificial*.

2 See Mitchell, *City of Bits*. Cf. Hayles, *How We Became Posthuman*.

3 For some background to such tendencies in technology see Aarts and Marzano, eds., *New Everyday*; Ishii, *Tangible Bits*; Streitz and Nixon, eds., "The Disappearing Computer," *Communications of the ACM*; Weiser, "The Computer for the 21st Century," *Scientific American*.

4 Manzini, *Material of Invention*, 27.

5 Jones, "Softechnica," in *Design after Modernism*, ed. Thackara, 216. See also Harvey, *Condition of Postmodernity*.

6 Bolter, *Turing's Man*, 103. See also Manzini, "Technical Power and Cultural Demand" (manuscript).

7 Archigram (lecture, Architectural Association, 1975), quoted in Pawley, "Archigram and the Retreat from Technology," *Oppositions*, 427.

8 Lyotard, *Les Immatériaux* (Paris: Éditions du Centre Pompidou, 1985) trans. and quoted in *Time Magazine*. See also Chaput, "The Demise of Classical Rationality," in *Design after Modernism*, ed. Thackara; Thackara, "Consumption and Creativity," in *Edge of the Millenium*, ed. Yelavich.

9 Dunne, *Hertzian Tales: Electronic Products*, 24.

10 For further background see, for example, Dourish, *Where the Action Is*; Winograd and Flores, *Understanding Computers and Cognition*.

11 Manzini, *Material*, 37.

12 Moles, "Design and Immateriality," in *Idea of Design*, ed. Margolin and Buchanan, 273.

13 Dunne, *Hertzian*, 33.

14 For further discussion see Aldersey-Williams, *New Cranbrook Design Discourse*. Cf. Abrams, "Adventures in Tangible Computing" (MA thesis); Ishii, *Tangible*; Moggridge, "Durrell Bishop," in *Designing Interactions*.

15 For indications of such problematics see Bishop's comments in Abrams, "Adventures"; Djajadiningrat, Wensveen, Frens, and Overbeeke, "Tangible Products," *Personal and Ubiquitous Computing*; Wensveen, Djajadiningrat, and Overbeeke, "Interaction Frogger," *Proceedings of DIS*.

16 See Miller, *Material Culture and Mass Consumption*.

17 Bishop, quoted in Abrams, "Adventures," 18.

18 Dunne, *Hertzian*, 22.

19 Manzini, *Materials*, 38.

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25 Manzini, *Materials*, 26.

26 Taylor, *Moment of Complexity*, 106.

27 Manzini, *Materials*, 183.

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29 Kennedy, in *Ultramaterial*, 19.

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31 Kennedy and Grunenberg, *KVA Material Misuse*, 9.

32 Schafer, "Designing Inefficiencies," In *Scanning: Aberrant Architectures*, ed. Betsky, Hays, and Anderson, 95.

33 Rowe, "The Present Urban Predicament" (lecture, 1979), reprinted in *As I Was Saying*, 167-8. See also: Rowe and Koetter, *Collage City*; Hays, "The Oppositions of Autonomy and History," *Oppositions.*

34 Mori, *Ultramaterial*, xiv. For some examples of the postmodern discussion see Thackara, ed., *Design after Modernism*; Schafer, "Inefficiencies".

35 Kwinter in Somol et al, "Status of Work on Form Today?" *ANY*, 65.

36 Whiting and Witte in Eisenman et al, "Eisenman (and Company) Respond," *Progressive Architecture*, 89.

37 Kwinter, *Architectures of Time*, 56. See Lefebvre, *Production of Space*.

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40 Tschumi, "City and Void," in *Idea of the City*, ed. Middleton, 141. See also Coates, "Ecstacity," in *Idea of the City;* Coates, "Street Signs," in *Design after Modernism*, ed. Thackara; Coates and Tschumi, *Discourse of Events*.

41 Tschumi, "Six Concepts," *Columbia Documents*, 88. See also Wigley, *Architecture of Deconstruction: Derrida's Haunt*.

42 Tschumi, "The Architecture of the Event," *Architectural Design*, 26.

43 Tschumi, "Index of Architecture," in *Questions of Space*, 99.

44 Coates and Tschumi, *Discourse*.

45 Tschumi, *Event-Cities (Praxis)*, 155.

46 Derrida, quoted in Hays, "Jacques Derrida, 'Point de folie'," in *Architecture/Theory/since 1968*, ed. Hays, 578.

47 Peralta, quoted in Borden, "Another Pavement, Another Beach" in *Unknown City*, ed. Borden, Kerr, Rendell, and Pivaro, 181.

48 Borden, "Body Architecture," in *Occupying Architecture*, ed. Hill, 215.

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49 Borden, "Another," 185-187.
50 Borden, "Body," 198.
51 Foucault, quoted in Allen, *Points and Lines*, 52.
52 Allen, *Points,* 54.
53 Allen, *Points,* 55.
54 Allen, "From Object to Field," *Architectural Design*, 26.
55 Allen, *Points,* 141.
56 Summerson, "Theory," 233.
57 Tschumi, "Architecture of the Event" 25.
58 Vidler, "Toward," *October,* 73.
59 Tschumi, "Index," 104-5.
60 Borden, "Another," 187.
61 Stern, "Gray Architecture as Postmodernism" (*L'Architecture d'Aujourdhui*, 1976), reprinted in *Architecture*, ed. Hays, 243.
62 Forty, forward to *Strangely Familiar,* ed. Borden, Kerr, Pivaro, and Rendell, 5.
63 Tschumi, *Disjunction*, 16.
64 Borden, "Body," 207.
65 Hays, "Bernard Tschumi," in *Architecture*, ed. Hays, 227.
66 Tschumi, "City," 141.
67 Allen, *Points,* 55.
68 Allen, *Points,* 55.
69 Tschumi, "Index," 102.
70 Tschumi, *Disjunction*, 163.
71 Allen, *Points,* 54.
72 Somol, "Architecture without Urbanism," in Allen, *Points,* 142.
73 Kwinter, *Architectures*, 167.
74 Debord, quoted in McDonough, "Fluid Spaces," in *Activist Drawing*, ed. de Zegher and Wigley, 102.
75 See Bolter, *Turing's Man*; Winograd and Flores, *Understanding Computers*.
76 Maeda, *Maeda@Media*, 25.
77 See Norman, "Design Principles for Human-Computer," *Proceedings of CHI*.
78 See Beardon, Gollifer, Rose, and Worden, "Computer Use by Artists and Designers," in *Computers and Design in Context,* ed. Kyng and Mathiassen; McCullough, *Craft*.
79 Kwinter in Asada et al, "Emerging Complexities," in *Columbia Documents*, 86.
80 Redström, "Technology," *IT+Textiles*, 23.
81 See Manzini, *Materials*; Jones, *Design Methods*; Akner Koler, "Formgiving and Aesthetical Abstraction" (PhD diss.); Akner Koler, Billger, and Dyrssen, "Cross Disciplinary Study in Complexity," *Proceedings of ERA*; Redström, "Designing"; Löwgren and Stolterman, *Thoughtful*.
82 See Redström and Mazé, "Form".
83 Grosz, *Architecture from the Outside*, 172, 170.
84 Grosz, *Outside*, 141. See also Grosz, ed., *Becomings: Explorations in Time*.
85 Benjamin, "Event, Time, Repetition," in *Columbia Documents*.
86 Kwinter, *Architectures*, 12.

* For further information about Smart-Its see: Smart-Its Project (website); Holmquist et al., "Building Intelligent Environments with Smart-Its," *IEEE Computer Graphics*.
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Material practice

The preceding section on 'Material life' explored materiality in light of challenges posed by post-industrial technologies. As discussed, computers are materially instantiated – as electronic parts and user interface – but increasingly complex, rapid, and extensive processes of computation intervene between. With miniaturization, size and shape may not reflect speed and functionality. Indeed, the 'disappearing computer' implies computation invisibly integrated into ordinary materials and familiar things. This situates the rather complex material conditions of technological objects – a combination of material, mechanical, and 'abstract machine', subject to natural laws and digital logics. To the extent that the complexity of such objects may not be immediately present or even spatially perceptible at all, they become less available to our conventional ways of thinking and operating, both in use and in design.

Certainly, we are becoming increasingly aware of the 'materialization' of computation. From the early days of user interfaces, the graphical, tangible, and multimodal possibilities have grown dramatically. On one hand, relations between appearance and action have been developed – semantic approaches expand the 'product language' representing computational operations on a product surface. On the other hand, materials in and of themselves are increasingly in focus in intersections between computer and materials science. Rather than in terms of spatial appearance, even the most traditional of materials are understood in terms of emergent and synergetic effects. Chemical, mechanical, computational, and other performances of new materials may be effected at nano, micro, and macro scales, with technology literally integrated as a material in building the form of materials and products.

Such an understanding implies a reconsideration of basic conceptions of form. Contemporary materiality simply cannot be accounted for only in spatial terms – typically central to discussions of packaging or representing the 'abstract machine' – rather, composite and dynamic performances must be taken into account. In fact, the particular material properties effected by computation are fundamentally temporal, characterized by how computer programs unfold and how computational processes evolve, in use, and over time. In synch with a more general shift – away from appearance to performance, in a materials perspective; 'beyond the object', in design discourse; and towards a notion of continual 'becoming', in a philosophical sense – form itself might be considered not just in spatial but temporal terms.

This opens up for a range of alternative perspectives on material formation, for example as deconstructivist and Situationist notions of 'event' in architecture counter formalist and functionalist conventions. Architecture is treated as an (a)semantic syntax for sparking the unexpected, as raw material to be reprogrammed in by phenomenal experience, or as a complex infrastructure evolving over time. Form is conceived in a continuous state of (de)composition, as diverse programs and practices interact, erupting in events that restructure the formal possibilities. Rather than ordering or determining what might happen in space, design might be understood as conditioning spatial and temporal relations, situating the material conditions for interactions and events to unfold among diverse and complex systems. Turning to alternative accounts and to basic definitions of form suggests a variety of ways in which we might consider 'temporal form' to emerge – by nature or design, and in use.

Summing up the previous section, thus, some concerns might be further addressed with respect to practice. In the contemporary situation, practitioners need to develop ways of thinking about and working with new materials, as a basis for understanding the functional and expressive possibilities. Since the design of technological objects fundamentally involves combinations of traditional and technological materials, in

interaction design we must find ways of relating to existing material practices, topics, and methods. As a basis for discussion, we might revisit existing notions of 'design materials' and 'computing as craft' in systems development and interaction design. However, these might be challenged and expanded given certain contemporary developments of material practice in engineering, architecture, and the applied arts.

These issues drawn from the previous section on 'Material life' synthesize some points for further discussion in the section on 'Material practice' to follow here:

Abstraction
Typically, technological objects are treated in terms of existing and new layers of abstraction and representation. Instead, we might consider how to work with such complexity in terms of the materiality of design practice.

Expressions
The dynamic performances of both technological and traditional materials suggest consideration beyond the appearance of spatial form. In practice, we must find ways of discovering and developing material expressions of temporal form.

Formation
Interaction design, in particular, must consider combinations of diverse materials – and material traditions. A material practice in interaction design must thus consider both traditions of spatial formgiving and approaches to giving form over time.

Working with materials

In contemporary design, we are a long way from traditional relations to materials. Once upon a time, materials for building came directly from local sites or communal resources, material knowledge was embedded in skilled action and persistent communities of practice, and makers were directly in touch with materials and in control of formation. Today, there is a range of techniques for representing and working with considerably more complex forms. Modes of representation enable overviews and management of complex development processes and computational tools precise manipulation of form to an extent far beyond ordinary human perception and physical abilities. The historical development of such techniques is often accompanied by a certain antagonism between craft and design, matter and technology. Without a nostalgic turn to the past or entirely cybernetic mode of practice, perhaps we might seek to refresh a basis for reconsidering relations between materials and form.

Examining some historical relations between design and craft suggests why certain threads of discourse have come to the forefront. Ancient craft practice might be characterized by tacit material knowledge, reliance on precedent and trial-and-error, and incremental evolution over long periods of time. However, as Ezio Manzini argues, even "matter is no longer a specific piece of wood or stone to which he must turn his hand, but an abstract model characterized by parameters (properties) and by relationships between those parameters." [1] During the Industrial Revolution, design emerged as a rapidly growing and increasingly professionalized sets of practices, distinct from traditional trade guilds and artisan practices. Along with new technologies, *techne* increasingly required *logos* – and thus the development of formal education, symbolic knowledge, and representational systems.

Mass-production interjected the need for advance planning and division of labor, with consequent need for formalized systems of representation to overview, communicate, and manage the whole. As Abraham Moles describes, "From 1850 to 1950, industrialization was characterized by the predominance of a system of drafted plans and diagrams, which were essential to the materialization of ideas, and which caused a proliferation of design patents." [2] With industrial production, new representational systems were developed to formalize the results of design conception, which were often handed off to other specialists and processes involved in execution. Increasing industrialization was paralleled by disciplinary fragmentation, specialization of tasks, and by increasing abstraction of design and production techniques.

This contributed to what is often held as a central tenet of design – the separation of conception and execution. If, in traditional crafts, a practitioner is typically in touch with their material and in control of fabrication, a primary characteristic of professional design is distance from materials and production. For example, Christopher Alexander, a proponent of the design methods movement in the 1960s, argued that "trial and error design is an admirable method. But it is just real world trial and error which we are trying to replace by a symbolic method, because real trial and error is too expensive and slow." [3] The 'scientific management' of the industrial era must be matched with methods suitable for working with new technologies, with a tendency to try and transpose human knowledge and experience to symbolic form.

Since drawings, diagrams, prototypes, simulations, and scenarios may even be the primary link between conception and execution, it is such modes of design representation or system description – rather than materials in and of themselves – that have thus taken precedence in much design practice. Materials may be considered in relation to their symbolic or phenomenal significance, as in tendencies within

industrial design exploring semiotics and emotion. Such significance, however, is not typically engaged at early stages in design conception. 'Conceptualizing' is typically separated from the concerns of 'finishing'. Thus, material considerations may often be left to specialized expertise, factors of economy, styling, or 'packaging' involved in final execution. As Peter Dormer once commented, "The modern orthodoxy is that conception and execution are separate activities and that execution – mere making – can take care of itself." [4]

Given such tendencies, it is not unexpected that 'materials' are not always in focus in HCI and interaction design. Within these fields, two topics have involved more specific discussion of relations between materials and practice – that is, notions of 'design materials' and 'computing as craft'. Each, in different ways, tries to address the challenges of contemporary design work with respect to the qualities of more traditional modes of practice. Thus, each redresses certain differences between craft and design in terms of relations between conception and execution, and between tools and materials. 'Design materials' indicates the artifactual modes of representation involved in creative work, and 'computing as craft' relates to the tools by means of which designers conceive, craft, and produce form. Each point to possibilities for material practice, though certain distinctions might be made and updated with respect to technological materials and contemporary practices in the applied arts.

A central reference in notions of 'design materials' is Donald Schön's account of designing as a 'reflective conversation with the materials of a situation'. [5] His pragmatic account involves a hermeneutic process of interpretation and creation, in which each design 'move' might be seen as a local experiment, reframing the design setting and, thus, the next move. In his perspective, a 'reflective conversation' might range from an engineer's experimental designing dependent on 'their feel for the behavior of metals under varying conditions' to the 'virtual worlds' constructed by town planners to project and rehearse scenarios of use. Thus considered, 'design materials' might include a range of things, from traditional materials, such as metal, to modes of representation, such as virtual models or diagrams.

Representations, or 'design materials', may serve to link separate phases within a development process, as 'boundary objects' to negotiate options, or as a common ground in a multi-disciplinary team. In HCI and interaction design, 'design materials' have been explored in relation to creativity, learning, tools, work, and collaboration. [6] The fields of Participatory Design (further discussed in 'Participatory practice') and Computer Supported Cooperative Work have been particularly concerned with such means for leveraging social context and skill involved in design work. For example, Pelle Ehn advocates updating romantic and historical ideal of craftsmanship to suit contemporary design and use of computational artifacts, pointing out the undesirable alternative: "The point is that if craft skill and autonomy are set as the ideal then we will in working life only find deskilled workers." [7] Generally speaking, 'design materials' refers to prototypes, mockups, or scenarios – materialized representations – in which the 'correctness' of materials is less important than the externalization of ideas within a design situation. Rather than the relation of materials to form, such notions tend to focus on the relation of representations to design work.

While not concerned with materials in precisely the same sense that will be developed further here, perspectives on 'design materials' do serve to shift a step closer. In a 'reflective conversation with materials', as Schön describes, there is an interplay between different types of representations to provoke continual reflection on the conditions within the situation at hand, rather than only projection towards a solution. Thus, in such a process including both material representations and

reflection-in-action, "Here the issue is not only, 'How do I make this artifact usable?' but also, 'What is this artifact?'" [8] We might follow the trajectory of Schön's remarks to shift focus from use ('How do I make this artifact usable?') to form ('What is this artifact?') and beyond – back to the basic materials that are used to build form.

'Computing as craft' is another response to the challenges of contemporary design work. Discussing 'virtual craft', Malcolm McCullough also shifts away from materials in terms of intent, utility, or usability. He argues, "Unlike objects of industrial design, for which the term affordances is also used in describing the potential purpose and self-evident uses of things, a medium is not necessarily established for a particular intent. Rather it is found. Its affordances are discovered." 'Medium' encompasses raw materials and design tools, whatever artifacts, techniques, or procedures might be bound up into design activity. He continues, noting that "the word 'medium' has many meanings: a medium may be a material, such as plaster, or a means, an agency, or an instrumentality… quite often the word signifies a class of tools and raw material... it can be difficult to say where a tool ends and a material begins." [9] Thus, he uses the term to subsume all the resources that might be taken up in design activity as a medium 'through' which a practitioner might work.

Such a notion is present in various conceptions of software design as craft. As John Chris Jones once remarked, "The more I see of software designing the more I notice resemblance not to design in other fields but to craftsmanship. In each the designing, if such it can be called, is done by the maker, and there is much fitting, adjusting, adapting of existing designs, and much collaboration, with little chance of a bird's eye view, such as the drawing board affords." [10] Similarly, David Wroblewski notes, "In our lab, for instance, we routinely make new programs by copying and editing old ones. Subroutine libraries (either tools or materials, depending on your perspective) often arise from the systematic extraction of code developed for a particular application whose generality and value to other programmers is recognized." [11] The work of computer programmers may quite literally resemble traditional craft – code is both something to 'work through', as a tool, and to 'work into', as a material. Thus, the difference between tool and material blurs, and a general notion of medium might be sufficient to account for the materiality of practice.

However, such a relation might be viewed rather differently from the perspective of the 'artist-designer'. As Gillian Crampton Smith notes, "It is difficult to catch ideas on computer the way you sketch notes to yourself – a pencil in the hand is like an extension of the brain. But at the moment the computer mouse can't be like that. You can't luxuriate in a material like you do in shaping clay or bending wood." Like a programmer, an artist or designer might work through software or computational tools. However, they often do so in order to relate to something else entirely, such as the composition of a piece of furniture or architectural object. Representations and descriptions are employed to 'work into' an entirely different set of materials and material combinations. Crampton Smith continues, describing that "with the computer, you have to envisage what you want it to do. You can't 'work into' your material in the same way as with traditional design methods." [12] The relation between raw materials and final product is thus mediated by additional and indirect means.

One way of treating the rift between conception and execution, thus, is in terms of the tools intervening between. A range of related efforts have been made to develop technological tools to aid in designing. For example, there are increasingly sophisticated computational means for modeling and sketching form, as evident in progressively more precise CAD/CAM software and 3D modeling systems with digital gloves or virtual reality. McCullough traces such efforts aimed at recovering the

immediacy of the human gesture and handicraft skill by means of the computational medium that, in fact, contributed to disjuncture in the first place. In such accounts, focus tends to be on the top level of abstraction – the user interface – to leverage gesture and skill. Modelling in 2-, 3-, or 4D may thus be seen as a continuation of interface evolution, improving upon previously mouse-based 'direct manipulation'.

However, such techniques do not merely serve to return us to more traditional or familiar modes of relating to materials or form. In such systems, space and time may be infinitely zoomed, morphed, and combined. Antoine Picon notes that "in the age of the computer and with the physics of solids and DNA manipulations, materiality is increasingly defined at the intersection of two seemingly opposed categories. On the one hand is the totally abstract, based on signals and codes; on the other hand is the ultra concrete, involving an acute and almost pathological perception of material phenomena and properties such as light and texture as they are revealed by zoom-like practices." [13] He argues that infinite zooming and virtual sketching do not – and, indeed, should not pretend to – resolve the fissures between conception and execution, abstraction and concreteness. Such new techniques are only that – new, rather than replacements of, other modes of practice.

Notions of 'design materials' and 'computing as craft' focus, primarily, on improving methods and tools for better integrating conception and execution in design work. Much development in design methods focuses on the role of representations in design work. Focus is not typically on materials in and of themselves or on relations between materials and form – for example, as the applied arts might look particularly at how wood and textiles build the form of furniture or architectural objects. The notion of 'design materials' that we tend to focus on in interaction design concerns representations of materials and form, and the role of such representations in design work – that is, materials as they are present and usable for design, rather than as something to be worked into and discovered in and of themselves.

Similarly, much of the development in sketching and simulation focuses on improving relations between activities of conception and execution, with respect to tools for exploring, representing, communicating, and testing ideas. The emphasis is typically on seamlessly replacing or improving upon traditional techniques by means of computational tools. Thus, making is indeed in focus – but more likely in terms such as mental models, kinetics, psychomotor skills, ergonomic fit, computer perception, and processing speed – not materials. Technology becomes merely a medium through which to achieve something else – rather than something that might itself be crafted in quite a material way, as something to 'work into', as Crampton Smith suggests with respect to traditional materials. It is precisely this idea that this section aims to revisit and develop by drawing in a range of other ideas and approaches.

Another way to consider a material practice in interaction design is in terms of 'technology as material'. Rather than conceiving of materials only in terms of their use for design work or as a general medium to work through to achieve something else, we might return to a more basic conception. The 'performance' of traditional and technological materials may be examined apart from design work and questions of use or usability. Revisiting rather basic definitions – such as, "material is what builds the thing; form is the way material builds the thing" [14] – we shift away from concerns of use, and even of form, to materials in and of themselves. Materials ('what it is' or 'what it does') are distinct from questions of form ('how' materials are combined and built up – for which purposes or through what means). This turns us to more fundamental notions than those typically treated in accounts of methods or tools.

Taking a more literal approach to the performances, expressions, and combinations possible with traditional materials, aspects central to the applied arts, we might reconsider relations to technological materials, concerns central to interaction design.

With respect to a notion of material practice, there are quite important reasons for reconsidering fundamental notions of materials in interaction design. First, dealing with both traditional and technological materials in the relatively new field of interaction design means that we must draw on traditions both of 'engineer-designers' and 'artist-designers'. Each has a history of material engagement in practice that is not yet as well developed in interaction design – for example, in the material traditions of craft, 'minor science', or architecture. Secondly, for the last century and a half, accounts of craft have been pitted against technology and industrialization, with the result that romanticized or oppositional rhetoric has perhaps not kept pace with contemporary developments in the field. [15] Indeed, the applied arts challenge materials understood merely 'for' design use or 'through' which to design. With increasing accessibility of technologies, various approaches have emerging in the applied arts that experiment and 'work into' technological alongside traditional materials.

In the following sections, a notion of material practice is developed from various perspectives. Engineering and, more particularly, the applied arts are revisited with respect to recent ideas in contemporary thinking and diverse fields of practice. In order to take a closer look at examples in practice, this discussion is taken in thematic rather than disciplinary terms, acknowledging a blurring of concerns and practices across domains of practice today. In such terms, a range of shared concerns for 'material expressions' may be located in fields as diverse as engineering, architecture, the applied arts – and interaction design.

Complex materials

Examining the historical development of materials reveals a close association between crafts and engineering. In his discussion of material complexity, Manuel DeLanda traces the study of material behaviors to empirically-oriented craftsmen or engineers, rather than to prestigious centers of 'pure' science'. [16] Cyril Stanley Smith, a historian of materials, points to the derivation of early philosophies of matter – for example, Aristotle's four elements – from association with those "whose eyes had seen and whose fingers had felt the intricacies of the behavior of materials during thermal processing or as they were shaped by chipping, cutting or plastic deformation." [17] Artisans have long understood that the behaviors of metal could be changed through repeated heating, rates of cooling, and hammering – processes characterized by complex dynamics rather than simple or linear behaviors. Complex behaviors, such as ductility in metals, were widely explored and applied, though scientific understanding of such complex behaviors has only been recently established.

DeLanda relates to such material practices by means of Deleuze and Guattari's distinction between two types of science – 'royal' or 'major' science and 'nomad' or 'minor' science. Royal science is that conducted at royal societies and academies, with a focus on abstract and general laws, while nomad science is conducted through practical experimentation in the field or laboratory. Ancient metallurgy might thus be qualified as 'minor science in person'. The distinction between the two modes is not categorical, nor does it coincide with that between basic and applied science – each has distinctive methodological approaches, but also different concerns. Additionally, the modes often interweave, exemplified by Newton's contemporary Hooke, who was as fascinated by kitchens, dockyards, and architecture as by general laws. Even while emergent sciences of chemistry tended to focus on simple and linear behaviors, rather than complexity, there continued to be influential exceptions from within,

such as alchemy. Resisting categorization, distinctions between major and minor science recognize different but interpenetrating concerns and modes of practice.

While the study of material complexity is now prevalent, with the emergence of a contemporary science of materials since World War II and atomic research, there are still distinctions to be made between major and minor science. The former tends to focus on stable and homogenous behavior, leading to a view of matter as an inert receptacle for forms imposed from the outside. In contrast, artisans and other minor scientists have a different conception – of 'teasing' a form out of an active material, with an attitude nearer collaboration than imposition. As Deleuze and Guattari articulate, "At any rate, it is a question of surrendering to the wood, then following where it leads by connecting operations to a materiality instead of imposing a form upon a matter." [18] Rather than abstracting typical properties, Stanley Smith notes, such an approach continually incorporates variable, unpredictable, and even new dynamics into reflective and embodied practice. While industry requires constant and uniform principles and major science concentrates on general laws, minor science actively explores and exploits differences, indeterminacy, and change.

Another distinction with respect to scientific practice is made by anthropologist Claude Lévi-Strauss. He used the term 'bricolage' to describe a certain early or prior (rather than primitive) scientific activity. Such activity is concerned with the present and with materials at hand, working from within a set of given constraints rather than with projection and planning. Lévi-Strauss compares the concerns of a 'bricoleur' with those of an engineer: "The 'bricoleur' is adept at performing a large number of diverse tasks; but, unlike the engineer, he does not subordinate each of them to the availability of raw materials and tools conceived and procured for the purpose of the project. His universe of instruments is closed and the rules of the game are always to make do with 'whatever is at hand' that is to say, with a set of tools and materials which is always finite and is also heterogeneous because what it contains bears no relation to the current project, or indeed to any particular project." [19] Via engineering and the social sciences, 'bricolage' has influenced HCI, for example as 'improvisation' in learning, 'tinkering' in systems development, and 'tailoring' by end-users.

As a mode of practice, 'bricolage' also involves a particular attitude. The 'bricoleur' shares with the scientist a concern for structures and rules. Indeed, the scientist and the 'bricoleur' are distinguished simply "by the inverse functions which they assign to event and structures as means and ends, the scientist creating events… by means of structures, and the 'bricoleur' creating structures by means of events." The mode of 'bricolage' has a logic, but one contrary to that typical in science. Such contrariness is an attitude in itself – Lévi-Strauss continues, explaining, "In its old sense the verb 'bricoleur' applied to ball games and billiards, to hunting, shooting and riding. It was however always used with reference to some extraneous movement: a ball rebounding, a dog straying or a horse swerving from its direct course to avoid an obstacle. And in our time the 'bricoleur' is still someone who works with his hands and uses devious means compared to those of the craftsman." [20] Thus, we might understand the "savage mind" of the 'bricoleur', employing devious means such as camouflage, disguise, and diversion, as distinct from the 'domesticated' mind of the engineer.

Considering these modes of practice reveals a range of alternative approaches and attitudes to working with materials. Besides major science, these explore other well-established modes of material practice, whether falling within, on the fringes, or contrary to more official approaches. DeLanda outlines a history of material exploration deeply intertwined with artisanal activity and mundane mechanics. Deleuze and Guattari's distinction reveals an interplay between abstract principles and practical

experimentation, and a sort of collaboration with materials. Lévi-Strauss suggests an eclectic and ad-hoc mode, characterized by a devious attitude. Each of the theories above is distinct to a field of study – technoscience, philosophy, and anthropology – with respective disciplinary concerns. However, the nomadic or minor scientist, the craftsperson, the engineer, and the 'bricoleur', possess a shared concern with materials, overlapping historical trajectories, and a common theme of, as Deleuze and Guattari put it, "experimentation in contact with the real." [21]

Compared to minor science and 'bricolage', relations to materials in architecture might seem significantly different. The former emphasize proximity to materials, direct engagement with formation processes, and pragmatic operation in relation to given conditions. In contrast, architecture involves projection in both spatial and temporal terms – an architect must imagine an alternative to a given material reality, to be built in the future, by a multitude of specialists in diverse domains. Architecture's relation to its material is indirect in this respect, relying on abstract systems of representation, description, and calculation. Indeed, architects in recent decades have been fascinated with technology in instrumental and representational terms, apparent in an interest in simulation and morphology, and semantics and meaning.

There is also a challenging reexamination of materiality underway today. Certainly, such issues have long been central to the thinking of Kenneth Frampton and others, drawing (sometimes problematically) on Heideggerian notions of place and place-making. More recently, alternative accounts and tactics have been pursued by Toshiko Mori, Frank Gehry, Kennedy & Violich, Diller + Scofidio, Stan Allen, and others, challenging the servility of technology, preoccupation with representation, and conventional working methods. For example, Stan Allen draws on Deleuze and Guattari's distinction between scientific modes to explore the interpenetration of concerns in architecture and to counter conventional dialectics of place/space, ideal/real, and theory/practice resonating in some phenomenological and pragmatic accounts. [22]

Materials
Material practice
Working with materials

While architecture is removed from its materials to a greater extent than, say, woodworking, it is nevertheless essentially concerned with material reality. As a basis for speculation about the future, architects nonetheless posses a knowledge of material qualities and construction effects, and they deal with the topographic, economic, and political reality of a site. Allen draws a broad distinction between practices that are primarily hermeneutic and material practices. Where the former are generally concerned with the interpretation and the analysis of representations, such as in practices of law, history, criticism, and psychoanalysis, the latter are activities that transform reality by producing new objects or organizations of matter. He outlines an idea of what such a material practice might entail:

> Material practices (ecology or engineering for example) are concerned with the behavior of large scale assemblages over time. They do not work primarily with images or meaning, or even with objects, but with performance: energy inputs and outputs, the calibration of force and resistance. They are less concerned with what things look like and more concerned with what they can do. Although these material practices work instrumentally, they are not limited to the direct manipulation of given material. Instead they project transformations of reality by means of abstract techniques such as notation, simulation or calculation. Material practices organize and transform aggregates of labor, materials, energy and resources, but they work through necessarily mediated procedures – operations of drawing and projection, for example – that leave their trace on the work. Material practices deploy an open catalog of techniques without preconceived formal ends. [23]

Concerns with materiality in architecture point to several important implications. For one thing, such a shift in focus draws attention away from conventional notions of design as primarily representational. Such notions have emphasized such things as the concept, the ideal, the meaning, and the symbolic dimension of design – obscuring the materials, site, and operational conditions. While an architect is not a builder – rather, a specifier of construction technique – he or she is explicitly concerned with such material realities even at a spatial and temporal remove. In practice, construction, concepts, and representation leave traces on and impact one another. This contests, in equal parts, notions of architecture as concerned with a realm of abstract ideas and as a return to 'truth to materials'. Instead, it implies that practice is fundamentally compromised, both ideologically and operationally. But, more importantly, it locates such a compromise in terms of material reality and in practice.

Secondly, the unique and dynamic factors in each design situation entails that a material practice must take a critical view on convention, continually renegotiating *in situ*. Stating "the pragmatic know-how of technique does not necessarily respect precedent," Allen argues that "material practices unfold in time, confident in the logical structure of the discipline as a starting point, but never satisfied simply to repeat, or to execute, a system of rules defined elsewhere." [24] There are echoes of the devious attitude of the 'bricoleur', or, as Allen might put it, 'radical doubt'. In this sense, such a position is not purely pragmatic nor solely constrained to the given and present reality, as 'bricolage' might be. Neither disciplinary precedent nor a given reality determine a static frame against which practice might be carried out. As opposed to other modes of practice, such as in science, that rely on stable laws against which to compare and test conformance, a material practice implies a shift to performance.

Thirdly, the mode of material practice, while explicitly concerned with material reality and taking an explicit starting point in things at hand in the present, also involves ongoing speculation on and intervention into the future. If the vector of analysis in hermeneutic practices typically points toward the past, design must position itself in the present in order to project and transform reality. As in 'event architecture', discussed in 'Material life', this implies strategies that are flexible and anticipatory, neither starting with nor progressing towards a pre-determined state, as might be the case with typical master-planning or problem-solving. Thus, as in minor science, a material practice would involve negotiation rather than imposition, and anticipation rather than determination. Just as a material practice is not – or not only – about the representation of the ideal nor material expression, neither is it about regressing to past conventions or predetermining the future.

Thus, we might understand how architectural practice, while different in certain respects from traditions of minor science and bricolage, might engage diverse and complex material concerns. A material practice recognizes an interpenetration of representational and concrete methods, speculative and practical concerns, direct and projective modalities. Rather than analyzing representations, perpetuating conventions, or imposing future solutions, such a practice involves action and production. Negotiation of complex and indeterminate variables is carried out practically, personally, and over time. The role of a practitioner in such a mode of practice involves critical and devious attitudes, as Allen puts it, a "tactic for dealing with an imperfect reality with a catalog of tools that is itself imperfect, or inadequate." [25]

Most importantly, a notion of material practice directs attention to material reality and things themselves. The focus is not on what materials or things might mean – but what they might do, how they might operate in practice, and evolve over time in use and in the world.

Tracing these alternative trajectories within scientific and architectural practice point to a range of concerns with respect to materials. In 'minor science', material behaviors are discovered through devious means and practical 'experimentation in contact with the real'. While 'bricolage' makes do with the conditions at hand in the present, architects may view past conventions and present conditions as a basis for future projection. In architectural notions of material practice, experimental and pragmatic concerns resonate as tactical and critical improvisation within an 'open catalog of techniques without preconceived formal ends'. Collaboration and negotiation characterize relations to materials in diverse modalities of practice, the particularities of which inflect additional operational, disciplinary, and representational issues.

Thus far, the discussion of material practice has been rather general – however, to understand of what a 'return to materials' might be like in practice, particularly with respect to technological materials, we might examine working approaches and examples. In practice, while disciplinary conventions must be taken into account (at least as a starting point), architects, engineers, artists, and craftspeople may share material concerns. There are, however, significant differences in history, methodology, modes of representation, and scale of production. In order to build a discussion focused not on respective differences, we must nonetheless locate some frames, even provisional ones, for taking a closer look.

Materials
Material practice
Materials in design

Indeed, disciplinary distinctions are being challenged within the applied arts in general. Linda Sandino notes that, historically, the identity of disciplines has been based on material specificity – as in ceramics, metalwork, textiles, and jewelry. [26] However, by the end of the 20th century, this material essentialism could not be sustained. Rather than perpetuating differentiation in terms of skill, function, ideology, or audience, Sandino considers instead 'material expressions' as a common ground for relating to shared conceptual and practical concerns among design, craft, and art. To examine what 'material practice' might be like in action, this discussion also takes a thematic approach to trace shared concerns among diverse fields of practice.

Some approaches

The approaches and examples below represent significant historical and contemporary tendencies, though not based on material or disciplinary specificity. 'Expressionism', 'D.I.Y.', and 'weaving' are essentially concerned with material composition and performances. Thus, implications for issues of 'abstraction', 'expressions', and 'formation' laid out at the start of this section may be drawn out within a context of shared concerns. While primarily oriented towards traditional materials and spatial form, there are also implications for temporal form and technological materials.

Expressionism

The applied arts have often sought to express the essential qualities of materials, as in modernist aspirations towards 'truth to materials'. In architecture, the unique structural and sculptural capacities of reinforced concrete prompted Le Corbusier to propose entire projects based on the 'new stereotomy' of "the concrete coming directly from the formwork." [27] The Expressionist movement sought in materials the 'inner source of form', as Hugo Häring articulates: "We want to examine things and allow them to discover their own images. It goes against the grain to bestow a form on them from the outside." [28] While ultimately realized in brick, Erich Mendelsohn's observatory for Albert Einstein was an icon of architectural expressionism originally intended to be in concrete. Such projects served to develop and expose the possibilities of newly discovered materials such as reinforced concrete.

In modernist product, furniture, and interior design, plywood was a primary material. For example, Geritt Rietveld aimed to reduce furniture to its essential, preferably standardized, components. His iconic 'Zigzag chair' developed as a series of experiments in the 1930s – variations in manufacture and material techniques included single-sheet fiberboard, triplex or four sheets of multiplex, steel-frame structure, piecework with additional supports and screws. While his ideal was a chair made from a single piece of plywood, only one approximating his vision was ever realized in limited production. This work was a precedent for Verner Panton's later S-shaped chair made from a single piece and process of plastic manufacture and Ron Arad's recent punk-inspired 'Strict Family' series in industrial metal. Typical of modernist expressionism and 'zeitgeist', Rietveld states: "The purpose of every stylistic period is not to come up with variations of form, but rather to find the true and only possible solution for construction and manufacture; a balanced whole in which the practical requirements of a practicable construction are solved in an economical fashion." [29]

Investigating contemporary material concerns, including those of computation, high-tech fabrication, and biotechnology, Marcel Wanders' 'Airborne Snotty Vases' was created in 2001. Using cutting-edge technologies such as digital 3D nano-scanning and 3D laser printing, mucus from the sneezes of patients with nasal cavity diseases was scanned, processed, amplified, and fabricated. A series of vases was produced according to five types of infection – the 'Pollinosis', 'Sinusitis', 'Influenza, 'Ozaena, and 'Coryza'. Just as the mucus is computationally amplified from a microscopic to vase-sized scale, the fabrication technique 'builds' up the form from plastic powder. Conceptually and practically, this is a formal enquiry into the microscopic materiality of biology and even nanotechnology, using high-tech means of amplifying materials normally restricted to science into sculptural forms for everyday use.

These examples illustrate how designers have historically worked with and expanded the expressive potentials of reinforced concrete, plywood, and biological materials, whether introduced by engineering or emerged from the laboratory. Within the realm of concerns of expressionism, such examples develop the expressions of a particular material by stretching its limits – to aesthetic extremes, as in Mendelsohn's Einsteinturm; limits of structure and manufacture, as in Rietveld's variations on a theme, and; conceptual statement, as in Wanders' vases. Experimenting with a variety of conceptual, structural, manufacturing, and formal concerns, the projects develop an aesthetic and methodological palette for working with particular materials.

D.I.Y.

Looking closer at plywood, however, exposes a trajectory not towards purity or 'truth' but the increasing interpenetration of materials and manufacture. Sheila Kennedy traces its origins from the 1880s, when it was considered an inferior and 'impure' substitute for real wood, to the consistent performance of standardized manufacture that has since elevated it to an idealized and 'pure' type. [30] The technical and industrial advances that brought about plywood in the first place also brought increasing diversity in application. Codification of wood stud production, the invention of the rotary cutter, and the perfection of glues and resins enabled manufacture of a strong, thin material with consistent appearance and behavior. Such properties facilitated a boom in cavity-wall construction, premised on rapid and cheap sheathing of a standard structural framework. Rather than the pure solids and structural transparency idealized in modernism, cavity walls contain voids where electrical, plumbing, heating, and other 'public services' are invisibly concealed.

In their practice, Kennedy and Frank Violich shift away from expression of discrete materials or the recovery of any sort of material essentialism. Instead, projects

such as 'Low-Velocity Floor' work with industrial and cultural conditions of plywood and cavity construction. In the project, industrial printing is used to deposit flexible electronics with emissive properties beneath the plywood surface of the floor. Perforated translucent inserts in the joints between plywood strips enable light to be emitted from below and for distribution of cool air from a system located in the cavities of the floor construction. Rather than the use of plywood to simulate a smooth, seamless, and 'pure' effect, the principle at work is disruption of the standardized mass-manufactured surface, exposing the hidden complexity of material composition and architectural construction. Kennedy notes, "Materials are no longer finishes that provide closure to a building. Instead they are critical starting points that open new possibilities… Cladding and shaping the hollow wall is therefore not a project of 'styling'; it is inherently an exploration of material research." [31]

The work of Kennedy & Violich relates to a rather subversive tradition within design investigating principles of 'Do-It-Yourself' (D.I.Y.), adhocism, or, as Aaron Betsky dubs it, 'Home Depot Modernism' after the large housewares retail chain in the USA. Other examples include Morphosis' incorporation of cars and scrap metal into buildings, John Dickinson's furniture out of plumbing supplies, and Lagombra's sampling of mass-produced products, for instance from IKEA, into hybrid product assemblages. Mass-production and popular consumption – rather than nature – provide 'raw materials'. Materials are scavenged from catalogs and junkyards, 'researched' in terms of their cultural and industrial roots, their aesthetic expressions and structural logics stretched to the extreme and repurposed into new forms. [32]

Materials
Material practice
Materials in design

In arts and crafts, the properties and culture of materials have long been explored and subverted, for example in readymades and collage, recycling and the 'throw away'. Such tendencies contribute to the dissolution of traditions of material essentialism, as Linda Sandino notes. Rather than disciplines preoccupied with a particular material, a range of emerging practices just as readily borrow and mix-and-match among materials, methods, and even final products. Even the 'poetics of rust', explored by John Ruskin during the Arts and Crafts movement, and the cultural status of 'patina' in the 18th century are re-appropriated. [33] Rather than optimization of properties, reduction to essentials, or expression, of the 'spirit of the age', idiosyncrasy, criticality, experimentation, – and temporality – come to the fore.

Weaving

While expressionism and D.I.Y. explore issues of material expression in primarily spatial terms, temporality is also the subject of certain investigations. It is precisely a temporal or procedural notion of assemblage that is at work in weaving. As detailed in Ann Sutton and Diane Sheehan's history of weaving, the technique has encouraged a natural incorporation of diverse materials. [34] For example, 15th- and 16th-century Japanese and Italian brocades combined paper, metal, and silk, and contemporary design and art pieces readily incorporate acrylics, rubber, fiberoptics, and found objects. In a chapter entitled 'Using Chance', Sutton and Sheehan describe the 'The Design Game', in which technique, color, yarn, fiber, finishing, and weave are subdivided into thirty possibilities, written on cards, shuffled together, and played out to generate the conceptual and structural basis for new weaves. In this example, the process of incorporating diverse materials into weaving on a loom is extended as a meta-process for determining the variables, rules, and qualities involved.

In fields ranging from textile art and design to art and technology fields, weaving as a temporal process of material assemblage and as a meta-process of pattern and rules has been explored. For example, Anneli Renborg's 'Eternity Knitting' is a simple piece that unravels continually from one end as the same material is used to

knit the other – the material is finite though the temporal process is infinite. Another sort of spatial-temporal feedback cycle is Kirsten Nissen's 'The Work of the Hand', which senses her biometric state while weaving and converts this into mathematical variables affecting the weave in real-time. Meta-processes have also been explored in terms of generative art. For example, Biothing laboratory uses algorithms to determine the speed of material fabrication, resulting in patterns of variable thickness and intricacy in polyethylene fashion accessories ('poli::matt' project) and in patterns of light distribution through a fiberoptic woven wall ('reticulars' project). These projects explore the material act of weaving in both spatial and temporal dimensions.

In a similar spirit, Frei Otto and his colleagues at the Institute for Lightweight Structures in Germany construct what they call 'material machines' from simple materials and procedures. The 'wool-water' technique, for example, involves a step-by-step procedure for stringing wool among points on a board and dipping the construction into water – over time, it becomes a patch of crossings and holes, in which the holes literally come to structure the whole. This is used to generate and prototype urban planning concepts. For example, the logic for stringing the wool might be the topography of a given territory, and nodal points might be tacks fastening a city map onto the board. Otto's work with such methods has pioneered advances in structural mathematics and civil engineering. Besides wool-water, other experiments include: "Sand, balloons, paper, soap film (including the famous minimal surfaces for the Munich Olympic Stadium), soap bubbles, glue, varnish." Such 'machines' set a spatial and temporal framework for interactions among material elements as they restructure themselves over time or, as Otto puts it, "find form." [35]

These examples build up aesthetic and structural complexity through simple spatial constructions and temporal processes – indeed, synergetic effects such as in wool-water are only achieved through intensive temporal treatments of materials. Indeed, perhaps it not so surprising that electronic digital processing in the 1940s was originally based on punch cards designed for Jacquard weaving. Rule-based processes were common both to weaving and computation, with richness and complexity arising out of novel combinations and permutations of simple conditions.

Material issues

In notions of 'expressionism', 'D.I.Y.', and 'weaving', aspects can be identified that are both mediated and direct, practical and critical, direct and projective. We can also see how material behaviors and modes of operation might relate to expressions and form. Tension and saturation, generation and disintegration, sculpture and structure, purity and infection – are material qualities explored conceptually, practically, and aesthetically. Distinctions between disciplines and methods, old and new materials, seem to lose relevance in light of a more primary and shared concern for material performance and experimentation. Revisiting the examples presented above with respect to issues of 'abstraction', 'expressions', and 'formation', material concerns are discussed below in relation to temporal form and technological materials.

Abstraction

The approaches presented above explore ways of working with materials more – or less – directly. While traditionally artisans have been directly in touch with their materials, 'teasing' out forms from an active material, other practices, such as architecture, rely on a knowledge of material behaviors and site conditions, carrying out experimentation through deployment methods at a spatial and temporal remove.

Rather than distancing practitioners from their craft, procedures and representation may be means to 'work into' the material possibilities. For example, Wanders'

adeptness with high-tech procedures amplified, literally and conceptually, the expression of a microscopic material. Kennedy & Violich and Lagombra are similarly savvy with the mediated nature of their practice. Their sources of 'raw' material include catalogs, D.I.Y. construction kits, and pop culture – design becomes a sophisticated reinterpretation of convention. Meta-processes such as the Chance Game, Nissen's woven biofeedback patterns, and Otto's 'machine' instructions deliberately distance the hand and control of the maker from material and formation. Digital processing, manufacturing standards, retail catalogs, games, instructions – and computational processing – are all bases for devious experimentation with parameters of distance. Acknowledging and even manipulating the spatial and temporal remove from materials allows unexpected qualities to emerge – by meta-design, chance, or accident.

Considering technological materials requires positioning in relation to multiple layers of abstraction and representation. Notions of 'tinkering' in HCI, for example, might involve engineering intervention deep into system parameters, or relatively superficial manipulation of parameters as perhaps more typical in end-user configuration.

Between atomic and superficial levels of engagement, a range of approaches are emerging, such as: Jonah Brucker-Cohen and Katherine Moriwaki's 'Scrapyard challenge'; Usman Haque and Adam Somlai-Fischer's 'Low tech sensors and actuators for artists and architects'; Victor Vina's 'Electronics and Crafts' workshops; Bill Verplank and Massimo Branzi's 'Box workshop'; David Cuartielles, Massimo Branzi, and Dave Mellis' 'Arduino', and; Smart-Its 'Hackfests'. These are platforms for learning techniques and experimenting with technologies at various levels of complexity. Haque and Somlai-Fischer, for example, rewire electronic toys, Brucker-Cohen and Moriwaki incorporate rubbish into electronic art, and Arduino open-sources hardware and software. As Verplank, Mitchell Resnik, and others have pointed out, such technological platforms support artists and designers in digging into and even expanding the conceptual and practical potentials of technologies. [36]

In this range of examples, makers are similarly concerned with their materials, deploying methods for discovery, control, or open-ended experimentation with possible expressions. In the examples from the applied arts, direct control over material behaviors is not a matter of choice between craft or technology – hands-on craft, meta-processes, or generative algorithms simply expand the 'catalog' of methods available. Practitioners from diverse fields may hack into ready-made electronic kits, incorporate Smart-Its into weaving processes, or experiment with building up complexity through combinations of simple behaviors in Vina's workshop. Updating views of traditional craft practice with these accounts of rather methodologically and technologically sophisticated practices suggests a continuum of shared concerns and even overlaps in ways of working with traditional and technological materials.

Expressions

With respect to expressions, these examples also illustrate a range of ways to approach both the spatial and temporal form of material compositions. As in 'minor science' and the applied arts, a range of qualities are latent within a single material (for example, metal), in material composition (for example, plywood), and in material combinations (for example, cavity walls). These materials may take on a variety of effects, from flexible and durable to rigid and brittle, depending on construction or processes of formation. Such processes – for example, applying moisture or tension and manipulating thermal or chemical conditions – may be manually, mechanically, or computationally controlled. Complex qualities may, in fact, emerge from combinations of quite simple materials or conditions, as in weaving and Otto's wool-water. The Chance Game and 'Eternity Knitting' expose inbuilt temporal logics of formation

by introducing reversals and chance. In such examples, parameters of time in operational procedures become central to 'teasing' out material expressions and forms.

Echoing the empirical experimentation of minor science and crafts, the incremental expansion of material possibilities in expressionism might be seen as a process of evolving possibilities within a body of practice. Rather than a single manifestation, it is the body of Rietveld's work and the canon of reinforced concrete buildings that constitute methodical enquiry into respective material expressions. In relation to a constant Zigzag shape, Rietveld explores variables within a basic set of elements – thickness of plywood, treatment of material seams, bolts and additional supports are systematically explored. Within the parameters of a basic set of materials, practical operations, and external conditions, such examples cumulatively map out and stretch the territory of expressive possibilities over decades.

In contrast to incremental variation and knowledge-building, Kennedy excavates prefab standards – materials as given by industry, not nature. It is not merely applications of materials that are explored, but the intervention of production and cultural factors into material composition. Rather than a raw material, plywood is processed, combined with glues and resins to produce a uniform material available in standard dimensions. 'Cannibal' materials such as pressboard made from waste scraps of rare and expensive woods further combine primary and tertiary methods of manufacture through re-processing and recycling. Such 'wood products' mix-and-match materials, qualities, and values. Kennedy & Violich disassemble and deconstruct, working into seams, imperfections, and constraints. 'Low-Velocity Floor', for example, does not take the seamless plywood surface and apparent solidity of the floor at face value. Instead, the gaps between standard pieces and hidden cavities in the construction are exposed, and other technological materials inserted. The result is a new surface, where industry standards are amplified and aestheticized, leaky and backlit.

These examples experiment with material expressions spatially and in time – in processes of formation, in individual bodies of work, in communities of practice – alongside evolving cultural and industrial systems. With respect to traditional materials, a give-and-take between practical experimentation and historical evolution becomes apparent. With respect to new materials, material combinations, and technological materials, such experimentation may be seen as central to development.

Formation

Practically speaking, these perspectives and examples suggest a range of approaches to 'experimentation in contact with the real'. For example, material possibilities may be discovered, explored, and expanded by tinkering and crafting, hacking and programming, combining and repurposing, in the laboratory or workshop. Such experimentation serves to map out a territory of material possibilities by example, to establish a platform of material or methodological resources for practice, and a palette of expressions available for design. Unexpected effects may result, whether by methodical probing, by chance, or by design. With respect to materials, these examples explore exceptions and irregularities, change and chance, aiming to open up and extent rather than fix possible expressions.

If behaviors may be understood as latent within a particular material or set of material combinations, it is up to material practice to 'tease out' or establish the conditions for behaviors to emerge. For example, the wool-water machine explores material behaviors at various levels – within a step-by-step procedure, materials are composed together; as a composition, various interactions between materials restructure the form of the whole, and; the effects are subsequently applied to urban planning.

The 'Airborne Snotty Vases' involve a sequence of acts: the act of sneezing produces a microscopic material, the act of scanning multiplies the scale of the material, and the act of laser fabrication builds up the amplified form again. In both cases, form is a result of a material's own behaviors, interactions with other materials, and operations of a maker. Rather than 'imposition' of form on inert materials or material reality, this resembles something more like collaboration – active materials, in combination, through experimentation, in embodied practice, 'find form'.

The relation between formation and form are explicitly investigated in two examples of weaving. Nissen's 'The Work of the Hand' involves a feedback loop between the activity of weaving and biometric reaction of the weaver. While the materials themselves do not change, how they are formed is unique to the place and time of a combined biometric and material performance. Biothing employs generative processes, such that every process of formation is unique. In 'reticulars', the form continually changes shape and light intensity, and in 'poli::matt', algorithmically varying the speed of the formative process fundamentally changes the resulting form. As Biothing's Alisa Andrasek notes: "This way of designing follows nonlinear logic, like wave functions in mathematics… You can control the nature of them, but not the final result. You're setting up certain conditions and then letting this genetic game play on its own." [37] Technology participates in formation, whether through direct transformation (the Snotty Vases, for example), incorporation of related effects (in Nissen's work), or appropriation of the design act (as in Biothing's projects).

In these examples, the role of practice is to establish the conditions for performances to unfold – within materials, material combinations, and in collaboration with operations of making. Distance to materials is not merely a matter of spatial and temporal proximity but of methodological choice. Such choice inevitably involves future projection, even in methods of chance where the unexpected is anticipated and set in motion. Even a metallurgist 'teasing out' form may discover complex behaviors along the way – not for the sake of scientific knowledge alone. In such material practice, it is not enough just to discover or accept the existing but to challenge and expand the possibilities. Thus, Kennedy & Violich are not just critical of present conditions but disassemble and repurpose them to entirely new effects. 'Material practice' involves experimentation, a certain devious or 'crafty' attitude to convention and invention.

Toward material practice

A common supposition in moving to a more technologically-oriented design practice is the impoverishment of material traditions. Noting the increasing dominance of representational techniques in materializing ideas, Abraham Moles laments the subsequent diminishing of the "material task of design" carried out in a workshop setting. He argues: "Affecting more than workshop activity alone, the trend toward immaterialism includes all projectional conception in a concrete model, a process which used to depend on a situation of permanent interaction between conception and construction. The dialectic game between the abstract (the idea, the mental vision) and the concrete (the struggle with the material and disparate tools and appliances) is giving way to work done essentially with a computer-integrated manufacturing at a computer desk." [38]

Certainly, design work today involves a diverse range of representational means and numerous methods for the conceptualization and execution of artifacts. The design of complex systems and high-tech products often entails specialization, fragmentation of tasks, and division of labor. The development of representational techniques and design methods thus becomes increasingly important, and much related work has been done in HCI and design research, including a variety of new techniques for prototyping, simulating, and sketching forms. If craft might be characterized by direct relations to materials and control over fabrication, new computational tools certainly achieve control over nearly infinitesimal detail and have decreased the separation between conceptualization and execution. Perhaps we could even say that 'computer-integrated manufacturing at a computer desk' may support re-engagement with, in Moles' words, 'the dialectic game between the abstract and the concrete'.

With new technologies impacting design practice in the 1990s, teaching staff at the Royal College of Art in London reevaluated the role of the traditional workshop. Jeremy Myerson noted a reaction: "We know our students won't physically make things when they leave… but their decisions will be based on the experience of making things." While the workshop no longer simulated the manufacturing process, "workshop practice and model-making skills were taking on another role – as part of the exploratory design process, providing an insight into form, shape and materials, and assisting in problem-solving and decision making." [39] Such a role of the workshop, alongside new techniques, points not to a depletion but to a diversification of methods available to designers today – with consequent need for renewing ways of thinking and making when it comes to materials and material traditions.

For one, we might recognize material practice as a sort of 'material research' or even 'material culture research'. Understanding 'technology as material' also requires getting to know the basic and particular properties available for the formation of new material expressions and functional performances. As Redström argues, "When working with a design material, we find ourselves within a framework that does not depend on 'use' in the rationalistic sense, but where questions of form, of expressions and aesthetics, provide a basis for exploring possibilities and characteristics of the materials at hand. For instance, to understand what it means to design things using clay, wood or textiles, we would make things using the materials in questions just to learn how they work." [40] Thinking and making in such terms – as might be traced from expressionism through to artists and designers tinkering with technology today – might be considered as a sort of basic material research for design.

Even as such material research may open a design space independent of questions about invention and application, these questions might also inform such research.

For example, examples of 'material culture research' recognize that design may not only reconfigure what is on hand, but excavate the cultural and industrial histories of materials (as in D.I.Y.), transform the scientific and aesthetic field (as in weaving and computation), or change industry (as expressionism did). Designers borrow from popular culture, but they do not just apply or copy what is there. Tracing currents in design – modernist college and readymades, postmodern adhocism and deconstruction – Aaron Betsky argues that such strategies are "a ludic form of criticism in which the absurdity of a design world becomes evident." [41] Instead of limiting ourselves to what is given, as in 'bricolage' and tinkering, we might expand such notions to acknowledge projective and critical modalities in design.

Rather than deskilling practitioners, a notion resonating in conventional oppositions between craft and technology, an expanding 'catalog of techniques' requires increased judgment and risk – practitioners are charged with developing 'tactics for dealing with an imperfect reality with a catalog of tools that is itself imperfect, or inadequate'. Mix-and-matching materials, methods, and knowledge between diverse fields need not be a matter of superficial analogy or 'tech transfer'. Kennedy articulates, "The antagonism between 'new' and 'old' materials, or between 'high' and 'low' technologies of production, may be dispelled through strategies that deliberately mis-use materials as a form of political action in architecture." [42] Plywood and pressboard may carry the force of powerful cultural commentary when their history and properties are carefully (de)constructed. Beyond mere application, a devious attitude may become 'radical doubt', as discussed further in 'Critical practice'.

Materials
Material practice
Toward material practice

Secondly, we might consider a need for a more basic and cross-disciplinary notion of material practice. Contemporary developments 'in the wild', outside the establishment, are posing quite significant challenges and producing very interesting results – disciplinary categories and historically-rooted debates are slower to change. Weaving biometric states and fashion fabrication by generative algorithm, hacking electronic toys, amplifying mucus through high-tech tools, civil engineering through wool-water machines, eternal knitting – these are activities that cross disciplinary bounds, with practical and theoretical implications. Just as craft has been marginalized with industrialization, as has 'minor science' within a wider field, perhaps such experimentation will be as well. Indeed, perhaps it must be, fueled by subversion and deviation of whatever norms are put into effect.

Crampton Smith characterizes 'artist-designers' as divergent rather than convergent thinkers, "working not by narrowing in to derive a solution, but by broadening out, constantly generating alternative ideas which in turn spark further alternatives. To work with this intentional uncertainty can feel vertiginous for designers from engineering disciplines, who have to think convergently to get results." [43] Material practice resonates with indeterminacy and divergence, even as vivid debates in the British Crafts Council between 'artist-craftspeople' and 'designer-makers' challenge institutionalized notions of skill and production. Thus suggests that we update a conception of 'artist-designers' in interaction design – not for purposes of interdisciplinary diplomacy but for staking out a space for creative difference. Divergent thinkers and devious practitioners – in the garage, the laboratory, or the workshop – might share and, indeed, are already actively negotiating common ground at the fringes.

Thirdly, working with complex materials, both traditional and technological, is no longer a matter of making do or mere application of what exists already. Rather than merely selecting from prefabricated standards, forms can be built up from 'atoms and bits' – we can design the performance of microstructures and bio- and nanotechnologies. Simultaneously, 'tinkering' and D.I.Y. are the subject of popular and

hobby culture – a growing number of people are engaging with material practice and technology development. There remain, however, differences between what can be done by hobbyists and end-users – and what can be done in design.

While notions of 'computing as craft' reveal affinities between software design and traditional craft technique, code may be the natural material for only some of the practitioners involved – the design of technological objects involves diverse disciplines and both technological and traditional materials. The examples above explore technological materials and temporal form in important ways – playing with in/finite spatial materials and linear time, meta-processes, generative algorithms, redesign, and chance, rust, patina, and ephemerality. Simple combinations and practical modalities in material practice open complex possibilities. As technologies become more accessible and prevalent in diverse fields of practice, we must better understand what the particular concerns and contributions of interaction design might be.

In order to return to basics, so to speak, this section has traced an alternative trajectory through familiar territory – that is, engineering, architecture, and the applied arts. Issues of material practice are central to the concerns of interaction design. While technological progress has prompted a discussion of immateriality and dematerialization, interaction design is specifically concerned with the presence, the spatial and temporal materialization, of new technologies. Looking to history, the development of new materials requires room for experimental practice and cultures of practice developed over time. Certainly, we are only beginning to understand the expressive and combinative possibilities of traditional and technological materials.

This discussion has looks beyond technology as typically approached by design in terms of representations and instrumentality. Tracing alternative trajectories in science and the applied arts, we might understand diverse concerns involved in 'experimentation in contact with the real'. To do so, we have shifted focus from use (as Schön puts it, 'How do I make this artifact usable?') and even form ('What is this artifact?'). Beyond is a space that we need to explore further – the expressions and combinations of traditional and technological materials that build the 'what' at all.

A notion of material practice, as developed here, speculates on what it might be to further develop a perspective on materials in and of themselves – not what they signify or what they represent, but their basic expressions and qualities – and how they build form. This means finding frames for thinking and making to explore the design space around 'what is' and 'what it does' as an essential area of research in and of itself, apart from other questions such as 'what for'. Rather than distancing makers from their materials or recovering the immediacy of the human gesture to representational systems, technologies might also be seen as a material to be explored, expanded, and worked into, rather than merely instrumental or applied.

In order to further develop such issues raised with respect to materials in practice, both conceptual and practical platforms are needed in interaction design and design research. Conceptually, there need to be frames developed for thinking outside notions of use and form, representations and instrumentality. Practically, there need to be means developed such that practitioners from diverse fields may 'work into' the materials central to interaction design. To build an argument and background above, existing and established fields of practice have been revisited – however, we must further develop notions of technological materials and temporal form. In order to further illustrate an approach to material practice in interaction design, the next section delves into one possible example, the design research program 'IT+Textiles'.

Notes

1 Manzini, *Material of Invention*, 53.

2 Moles, "Design and Immateriality," in *Idea of Design*, ed. Margolin and Buchanan, 271-2.

3 Alexander, *Notes on the Synthesis of Form*, 70. Cf. Thackara, "Beyond the Object in Design," in *Design after Modernism*, ed. Thackara.

4 Dormer, quoted in Lees-Maffei and Sandino, "Dangerous Liasons," *Journal of Design History*, 211. For another discussion of design as 'finishing' see Beardon, Gollifer, Rose, and Worden, "Computer Use by Artists and Designers," in *Computers and Design in Context*, ed. Kyng and Mathiassen.

5 See Schön, *Reflective Practitioner.*

6 See, for example: Binder, Brandt, and Buur, "User-Centeredness and Product Development," *Proceedings of PDC*; Buur and Bødker, "From Usability Lab to 'Design Collaboratium'," *Proceedings of DIS*; Bødker and Christiansen, "Designing for Ephemerality and Prototypicality," *Proceedings of DIS;* Ehn, *Work-Oriented Design*; Fischer, "Social Creativity," *Proceedings of PDC*; Fällman, "In Romance with the Materials" (PhD diss.); Sengers, Boehner, David, and Kaye," Reflective Design," *Proceedings of Critical Computing*.

7 Ehn, *Work-Oriented*, 372.

8 Schön quoted in Bennett, "Reflective Conversation with Materials," in *Bringing Design to Software*, edited by Winograd, 181.

Materials

Material practice

Notes

9 McCullough, *Abstracting Craft*, 199,193.

10 Jones, "Softecnica," in *Design after Modernism*, ed. Thackara, 219.

11 Wroblewski, "Human-Computer Interfaces Considered as a Craft," in *Taking Software Design Seriously*, ed. Karat, 10-11.

12 Crampton Smith, quoted in Myerson, "Tornadoes, T-squares and Technology," in *Culture of Craft*, ed. Dormer, 180, 179.

13 Picon, "Architecture and the Virtual," *Praxis*, 119. For an account of time-based techniques and analysis, see Keller, "Versioning, Time, and Design Culture," *Architectural Design*.

14 Redström, "Technology as Material," in *IT+Textiles*, ed. Redström, Redström, and Mazé, 22.

15 See Lees-Maffei and Sandino, "Dangerous Liasons".

16 See DeLanda, "Material Complexity," in *Digital Tectonics*, ed. Leach, Turnball, and Williams.

17 Stanley Smith, "Matter Versus Materials," in *Search for Structure*, 115.

18 Deleuze and Guattari, *Thousand Plateaus*, 408.

19 Lévi-Strauss, *Savage Mind*, 17. In HCI and related fields see for example, Brown and Duguid, "Organizational Learning and Communities-of-Practice," *Organization Science*; Cioborra, "Improvisation and Information Technology," *Proceedings of ACMIS;* Dahlbom and Mathiassen, *Computers in Context*; Nardi, *Perspectives on End User Computing*.

20 Lévi-Strauss, *Savage*, 22, 16.

21 Deleuze and Guattari, *Thousand*, 12.

22 See Frampton, *Studies in Tectonic Culture*; Frampton, "Place-Form and Cultural Identity," in *Design after Modernism*, ed. Thackara. Cf. Dovey, "Place / Power," *Architectural Design*; Dovey, *Framing Places*; Moore, "Technology, Place and the Nonmodern Thesis," *Journal of Architectural Education*.
For some material tendencies in contemporary architecture see Allen, *Practice: Architecture, Technique and Representation*; Allen and Foster, "A Conversation with Kenneth Frampton," *October*; Betsky, Hays, and Anderson, eds., *Scanning: The Aberrant Architectures;* Kennedy and Grunenberg, *KVA: Material Misuse*; Mori, ed., *Immaterial/Ultramaterial*.

23 Allen, *Points and Lines*, 52-53.

24 Allen, "Practice vs Project," *Praxis*, 116. See also, Bryson, "The Erotics of Doubt," *New Observations*.

25 Allen, "Project," 117.

26 See Sandino, "Here Today, Gone Tomorrow," *Journal of Design History*.

27 Le Corbusier, quoted in Sekler and Curtis, *Le Corbusier at Work*, 167.

28 Häring, quoted in Frampton, *Modern Architecture*, 122.

29 Rietveld, quoted in *Origin of Things*, ed. te Duits, 85.

30 See Kennedy and Grunenberg, *KVA*. See also, Kennedy, "Electrical Effects: (A) Material Media," *Praxis*.

31 Kennedy and Grunenberg, *KVA*, 10.

32 See Betsky, "The Strangeness of the Familiar in Design," in *Strangely Familiar*, ed. Blauvelt; Bloemink and Cunningham, eds., *Design ≠ Art*; Jencks and Silver, *Adhocism*; Jönsson, ed., *Craft in Dialogue;* Robach, ed., *Konceptdesign*.

33 See Sandino, "Here Today"; Attfield, *Wild Things*.

34 See Sutton and Sheehan, *Ideas in Weaving*; Dormer, "Textiles and Technology," in *Culture of Craft*, ed. Dormer.

35 Otto, quoted in Spuybroek, "The Structure of Vagueness," *Transurbanism*, 65.

36 See, for example: Moriwaki and Brucker-Cohen, "Lessons from the Scrapyard," *AI & Society*; Brucker-Cohen and Moriwaki, "Hacking the Street," *Proceedings of Outside In*; Haque and Somlai-Fischer, "Low Tech Sensors and Actuators" (website); Somlai-Fischer, "DIY Media Architeture," *Proceedings of Outside In*; Vina, "Box. Open System" (report); Verplank and Branzi, "Box Workshop" (workshop); "Arduino," *Proceedings of Prix Ars Electronica*; Arduino (website); Smart-Its Hackfest (website); Smart-Its Project (website); Verplank, Sapp, and Mathews, "A Course on Controllers," *Proceedings of NIME*; Resnick, Bruckman, and Martin, "Pianos Not Stereos," *interactions*; Schneiderman et al, "Creativity Support Tools Workshop," *Journal of Human-Computer Interaction*.

37 Andrasek, quoted in Vanderbilt, "2005 Next Generation Winners," *Metropolis*, unpaginated.

38 Moles, "Immateriality," 271.

39 Myerson, "Tornadoes," 178.

40 Redström, "Technology," 21.

41 Betsky, "Strangeness," 49.

42 Kennedy and Grunenberg, *KVA*, 20.

43 Crampton Smith, "The Art of Interaction," in *Interacting with Virtual Environments*, ed. MacDonald and Vince, 91. See also Crampton Smith and Tabor, "The Role of the Artist-Designer," in *Bringing Design to Software*, ed. Winograd.

Materials
Material practice
Notes

IT + Textiles

Materials
IT + Textiles

IT+Textiles was a design research program investigating textiles, in relation to the increasingly smart material behaviors, and information technology, in relation to aesthetics and meaning. As technology offers the potential for radically new forms and functions, its products increasingly pervade everyday, intimate, and domestic life. IT+Textiles shifts from a focus on the use of computers, to what it might be like to live with computational things.

Outlining "A Design Research Program for Textiles and Computational Technology", Lars Hallnäs, Linda Melin, and Johan Redström set out the aims as "deepening our understanding of (1) computational technology as design material, (2) textile as design material and of (3) the more general question of the interplay between spatial and temporal form elements in design." [1]

The program was guided by the theme 'technology as design material'. Redström points out that in domains such as textile design other questions besides those of functionality and user experience typical of technology development may be explored, since how such materials will be eventually used is to a large extent unknown. [2] Taking a non-functional account of technology opened up new ways of thinking about relations between design and use.

With IT and textiles as two primary materials, the program took an experimental design approach to investigate expressions and presence, aesthetics and temporal form. IT+Textiles intended to develop perspectives and examples with respect to:

• Computational technology as a design material – drawing on textile and fashion design, the expressions and aesthetics of computation as a design material

• New textile materials – integration of technology into textiles to suggest new materials for textile design and related application areas

• The interplay between spatial and temporal gestalt in the design of everyday things – spatial expressions of computational processes and temporal structures

The program was set up as an open arena for collaboration among multiple disciplines and domains, with research based on project work and the creation of design examples.

To accommodate diversity, project work was structured around two fomats: short, focused projects or studies done by one to three people, often based on a particular material or disciplinary methodology, and larger group projects. In this way, more experimental work was conducted along with more traditional and ongoing projects. Small projects were often experimental, probing into peripheral domains or risky ideas, often injecting fresh perspectives into ongoing work, or developing new methods and collaborations. In such an inclusive approach and open structure, predictability of outcomes was neither possible nor desirable – instead, the intention was to support experimentation as a driving force for an expedition into a largely unknown design space.

Formal and informal collaborators brought a diverse range of interests and competences, from the traditional Swedish textile industry centered in nearby Borås, design and product companies, research and academic institutions, technology and service developers. Outcomes ranged from product manufacturing concepts to academic publications and art exhibits, from spin-off companies to educational curricula.

IT+Textiles is more extensively documented elsewhere. [3] Brief descriptions of three – from among many – projects developed within the program are presented here, to illustrate methods, concerns, and examples for the purposes of the discussion to follow.

Scope
4 years, 2001-2004

Program leader
Johan Redström, Interactive Institute

Partners
Interaction Design Group at Chalmers University of Technology, Interactive Institute, Ludvig Svensson, Newmad Technologies, Swedish School of Textiles at the University College of Borås

Sponsor
VINNOVA, the Swedish Agency for Innovation Systems

Material studies

As a basis for exploring a range of material expressions and behaviors possible with IT and textiles, many physical samples were created. *Materials studies* catalogs samples generated within IT+Textiles.

Each was an experiment with different types of material composition (for example, texture, pattern, dyes, weave, or construction) and temporal behavior (for example, dynamic patterns reflecting sound, touch, light, or other conditions).

Similar to the samples found in hobby or home stores, collectively these represented a palette of textile and technological combinations, and of aesthetic effects and temporal behaviors. Resulting samples generated new or filtered into existing projects, as conceptual and practical building blocks for ideation and collaboration.

Project team
Anders Ernevi
Henrik Jernström
Peter Ljungstrand
Carolin Müller
Linda Worbin
Maria Åresund

Process
Samples were the result of rapid and collaborative experiments, within which material selection, expressive effects, and working methods were discussed and created between textile designers and others with backgrounds such as in the social sciences, interaction design, or electrical engineering

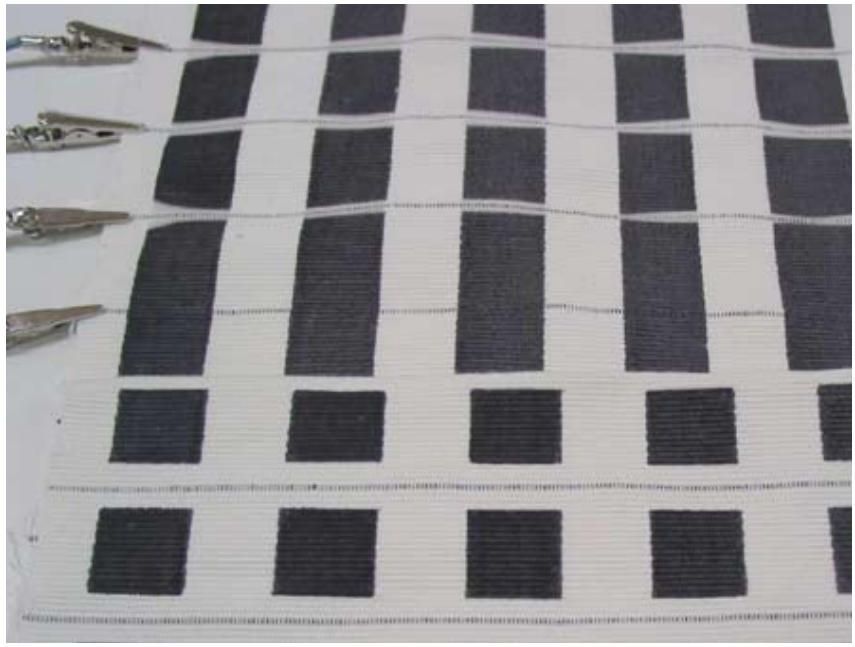
Samples were also generated by theme – 'party textiles' reflected the spatial and temporal aesthetics of events characterized by multiple textile artifacts. Effects reflecting or triggering social behaviors and moods were explored, as well as progression within a particular event or slow changes building within a holiday season.

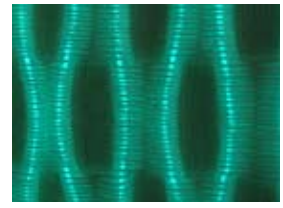
Outcome
Multiple material types and techniques were investigated – including various types of yarns and inks integrated into prints and weaves, sensors, actuators, microprocessors, processing, and communications devices.

For example, one sample integrated electroluminescent wire and film into patterns within the textile weave, with power, processing, and interchangeable sensors extended on wires. Thus, pace and sequence of lit patterns corresponded to inputs from any range of sensors monitoring local sound and light.

Another weave had printed patterns in ordinary and thermochromic ink and carbon-fiber yarn integrated into the weave. Depending on communication with other devices, the carbon fibers heated up, causing certain heat-sensitive parts of the print to disappear, effectively changing the textile pattern.

Materials studies were driven by local and ongoing experimentation, as tests of expressions possible with a certain set of materials, as probes into more focused ideas, or as mock-ups of alternatives for projects underway.





Reach

Reach investigates dynamic aesthetic expressions in clothing and accessories.

A clothing line developed as a series of 'wearable sketches', no- or low-tech prototypes with various combinations of cotton and linen weaves, conductive, UV-sensitive, thermochromic, and electro-luminescent materials, and sound, heat, and light sensors.

The line included hats, bags, and scarves created as playful interjections of personal, social, and environmental information into everyday fashion.

Generating a palette of expressions from a basic set of materials, the items suggest the possibility for a emergent wearable 'vocabulary' that mirrors and generates interactions in the social sphere.

Project team
Anders Ernevi
Margot Jacobs
Linda Worbin

Outcome
Drawing on a tradition of personal and cultural expression in fashion, the wearable line expresses the dynamics of situated and social encounters. Each item intervenes into particular social patterns with new, dynamic textile patterns.

- 'Reach out hats' share patterns based on proximity
- 'Torch bag' lights up when opened in the dark
- 'Reach in bag' animates to reflect surrounding sound
- 'Reach around scarves' reflect body and local heat

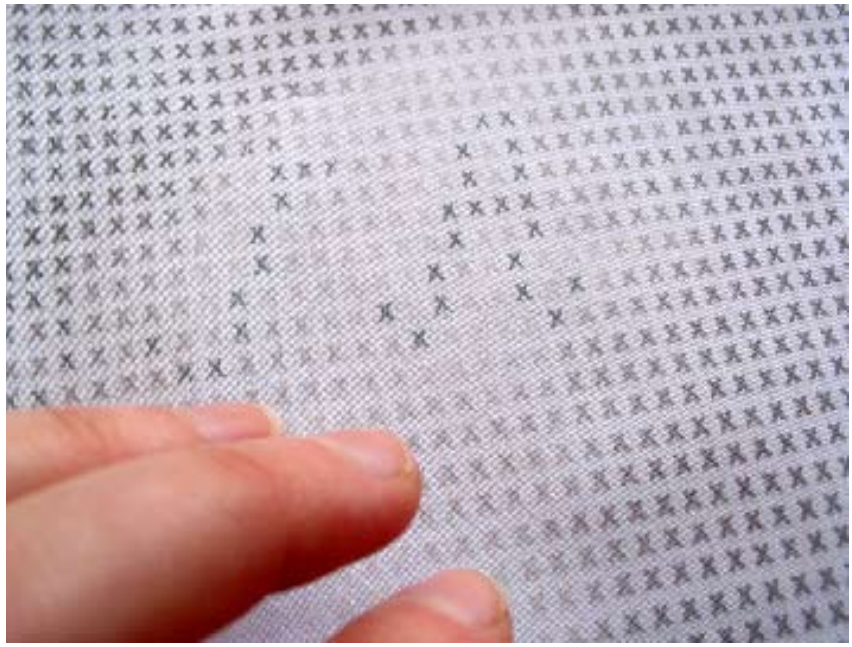
Design principles
The line explores a range of expressions based on simple additive and subtractive principles of pattern.

For example, each of the scarves explores a different principle. One has an additive pattern, in which different types of ink are printed as a solid color. When conductive fibers are heated, the thermochromic ink changes to another color and causes stripes to emerge. The other is subtractive – parts of a crosshatch pattern disappear when heated, causing messages printed underneath to be revealed.

Through variations within a basic set of materials and design principles, physical composition and temporal dynamics, a wide range of rather complex expressions were generated.

An example of gradually emerging dynamics are the patterns of 'Reach out hats', which grow more or less alike based on proximity – the growth of flower patterns on each reflect the temporal dimensions of the spatial relations between two people.

An example of dramatic expression is the 'Reach in bag', which achieves visually complex patterns based on quickly alternating the lighting of a simple set of interwoven electroluminescent strips – a strong expression reflects both subtle sonic ambiance and instantly animates to surrounding music.



Ramia Mazé Occupying Time

Tic-Tac-Textiles

'Tic' and 'tac' are two pieces of furniture, ideal for tea and coffee breaks. Taking a seat on 'tic' and setting a hot cup on the attached table activates hidden marks arranged in a grid pattern in the table's textile surface. Part of this pattern – an 'x' or 'o' mark – is communicated to the textile surface in 'tac'.

By intention or accident, marks are discovered and sent, engaging participants in an aesthetic and subtle game of 'tic-tac-toe' that lasts just as long as the coffee stays hot.

Tic-Tac-Textiles is a waiting game – embedding the possibility of playful communication as a secondary function of ordinary furniture objects.

Project team
Daniel Eriksson
Anders Ernevi
Margot Jacobs
Ulrika Löfgren
Ramia Mazé
Johan Redström
Johan Thoresson
Linda Worbin

Process
The project began as a study of waiting, in which ethnographic studies uncovered minute patterns of behavior in in-between and down-times.

Exploring the idea that communications technologies are generally considered to be time-saving devices, concepts emerged out of observations that not only do such devices actually introduce new waiting times (for instance, booting up a computer or waiting for updates in train schedules), they might also provide supplemental activities for play and exchange in the meantime.

Outcome
The furniture objects were crafted with particular attention to spatial and temporal expressions of waiting in public. The furniture is modular, and can both be arranged and sat on in a variety of ways, for shared or individual use of a single double-functioning table surface.

Communication between the objects is by radio frequency or internet protocol, such that use by participants may be co-located or distributed between different locations.

A plastic sheet beneath the thermochromic tablecloth is printed with conductive circuits in the pattern of 'x's and 'o's and embedded with heat sensors – a cup's heat is sensed and transmitted to the other table's surface, where it causes the conductive pattern to heat up and change the tablecloth in a corresponding pattern.

The game proceeds slowly, entirely dependent on the temperature of the cups involved in both coffee-drinking and game-play.

The previous sections on 'Material life' and 'Material practice' raise a discussion about materials in design, in conceptual and practical terms. Increasingly, information and communication technologies are integrated in everyday things. Even the most traditional of materials may become 'sensitive' and 'sensible' with the dynamics of mechanical and chemical performances – and computational interactions. Smart materials and the 'disappearing computer' suggest increasing overlaps between computer and materials science, each concerned with the basic building blocks of our material world. In addition, a range of applied arts practitioners have been actively experimenting with complex and technological materials. Such developments are mapping out a significant new design space.

Interaction design combines 'old' and 'new', 'low-' and 'high-tech' materials. Beyond more general concerns for 'design materials' or 'computing as craft', we might locate a more fundamental basis for material practice in interaction design. For example, we might examine the material properties particular to post-industrial technologies. Treating 'technology as material', for example, puts the 'temporal form' of new functional performances and aesthetic expressions into focus. In practice, since interaction design involves both traditional and technological materials, this means relating to existing material knowledge and practices. Interaction design must take root in traditions of the 'artist designer' and 'engineer designer' without reverting to entirely nostalgic notions of craft nor merely instrumental notions of technology.

This need not imply that the knowledge and methods particular to diverse disciplines can or should merge. Indeed, the material practice of diverse disciplines is changing – for example, with renewed interest in 'material research' or 'material culture research' in architecture, and as artists and designers, hobbyists and hackers, appropriate and tinker with new materials. Further, in design research, we might be wary of replacing the 'savage mind' of the 'bricoleur' or the 'radical doubt' of the critical designer with entirely scientific or purely pragmatic modes. While relations between disciplines and between research and practice may blur and overlap, we must find ways to accommodate differences in modality, method, and attitude.

Thus summing up the two previous sections, this also serves to contextualize 'IT+Textiles', a design research program that I have been involved in and can thus describe in more depth and reflect upon more personally. While the program was developed and carried out prior to the development of this text, there are nonetheless some relevant afterthoughts and speculations that might be drawn out, as follows.

In IT+Textiles, a range of material concepts and applications were developed by joining together diverse domains. Certainly, there are connections between information technology and textiles – such as the shared history of Jacquard weaving and punch-card computation, as well as a certain critical mass of traditional textile industry and high-tech development in the west of Sweden. Enquiring into the materiality of these domains, and potential synergies and applications as they might be combined, we also wanted to better understand different ways of thinking and making.

Thus, we tried to frame an approach both to explore material issues and potentials – and to enquire into multi-disciplinary work. We considered how to avoid simplistic borrowing of one discipline into another – for example, engineers as technical support for integrating new materials into textiles, or, vice versa, textiles as 'packaging' for softer-looking technological devices. One approach to this was our use of 'experimental design' to describe the conjoining of two terms that sit rather uneasily with one another from either a scientific or artistic perspective.

Experimental design

Experiments are the primary means by which scientists extract knowledge from the world. In an (idealized) scientific experiment, systems are divided up into distinct variables, which may be isolated, fixed, and tested through repeatedly running an experiment. As a result of simplification and repetition, unexpected or emergent factors may be observed and controlled – whether viewed as 'novelty' or 'error', depending on one's point of view. For example, in typical trial-and-error evaluation in product development, 'error' is precisely that which is divergent – and implicitly undesirable. Since interaction design has close ties with science and technology as well as the social and behavioral sciences, it is of course natural that such traditions of experimentation are present in research.

Indeed, experimentation might contribute to 'enquiry' posed in more general terms, as is evident within the pragmatic tradition. Charles Pierce, for example, extended a 'laboratory habit of mind' to enquiry in action – "In the laboratory, experimental action is actually arrested by emergent, exceptional fact; and the experimenter is forced to revise or reject the hypothesis or belief upon which the experimental action was predicated. Experimentation is the 'difficult art', the technique of seeking out emergent exceptions… this 'difficult art' of instituting doubt." [4] Describing the 'reflective practitioner', Donald Schön argues, "Doing extends thinking in the tests, moves, and probes of experimental action, and reflection feeds on doing and its results. Each feeds the other, and each sets boundaries for the other… Continuity of inquiry entails a continual interweaving of thinking and doing." [5] Emergent exceptions, the institution of doubt, and the interweaving of thinking and doing might be said to characterize experimental action in general.

Indeed, experimentation quite literally reveals rather close relations to design. Any experiment involves, for instance, the choice to do an experiment, a process of setting it up, determination of criteria for success, qualification of outcomes, new hypotheses, resetting, rerunning, and so on. Arguing, "We design experiments, but we also act as designers in how we act in these experiments," Ranulph Glanville concludes, "And, therefore, (scientific) research is a form of design – a specifically restricted form." [6] As Hallnäs and Redström note, "We design experimental methods and experiments, thus design practice is an important part of empirical scientific practice." [7] In such terms, a specific test, an experimental practice, even a program of enquiry might be understood as deliberately designed, with a range of different possibilities for relating variables and seeking out the exceptional.

In IT+Textiles, a notion of 'experimental design' framed a space for design discovery and hands-on enquiry perhaps atypical to user-centered design and IT development familiar to participants. While the term 'experimental' implies different things in different disciplines, our use relates the conjunction of 'reflection' and 'action' in open-ended and speculative practice. This might be evident at the programmatic level – for example, as a relatively open structure carried into action by means of short and longer projects. In particular, short studies facilitated provoked reflection, intervening new perspectives into the project which might lead to redirection – for example, 'Tic-Tac-Textiles' evolved from an unexpected intersection of ethnographic, material, and furniture studies. Our intention was to move beyond formalized structures and predetermined methods for research inquiry or design activity, to catalyze unexpected possibilities within a relatively unknown design space.

As evident from 'Material practice', experimentation may entail direct and critical engagement with material complexity, messy reality, and future uncertainty. Mak-

ing a distinction between material and hermeneutic practices locates experimental action precisely within everyday, operational, and projective modalities. For artisans and engineers typical of 'minor science', 'experimentation in contact with the real' exposes complex dynamics and emergent properties – and not for the purposes of reducing such phenomena to simple, linear behaviors or abstract laws, which more properly characterize the domain of 'major science'. It is not that they lack objectivity or method – indeed, knowledge and conventions provide necessary starting points. However, these are only provocations to expand the realm of the possible by producing alternative expressions, critical counter-proposals, or 'the new'.

Crafts are characterized as 'the workmanship of risk'. In contrast to 'the workmanship of certainty', as David Pye describes, in which the quality of the result is predetermined before anything is made, in craft practice the quality of the result is continually at risk during the process of making. [8] Thus, a counterpart to 'experimental action' in science might be located in traditional approaches to making. In IT+Textiles, such a spirit characterized both the textile and technical mindsets – 'Material studies', for example, extended trial-and-error piecework from weaving and tinkering from engineering. Sensors and solar cells, inks and yarns, mechanical toys and Smart-Its were gathered, deconstructed, and combined for new purposes. [9] Such 'bricolage' grew into a kind of tangible and open-ended sketching, resulting in a range of hybrid samples, which acted as testbed for trying out spatial and temporal variables.

Materials
IT+Textiles
Experimental design

In this project, as in others in IT+Textiles, emergence was explicitly in focus. Making combinations and alterations within a basic set of electroluminescent materials, yarns, weaving techniques, and sensors generated an enormous range of dynamic aesthetic expressions. Such experimentation stretched respective disciplines to the limit. For example, it was not possible to realize certain materials combinations on standard looms – a particular setup had to be configured, or 'tuned', to generate a weave from unconventional materials and material combinations. Similarly, new techniques had to be developed for connecting woven fiberoptic and carbon fibers to other components. Conceptually and practically, the project involved the generation of new aesthetic expressions, material techniques, and even skills. Rough-and-ready methods were developed through practical making, effectively extending the techniques of respective practices and supporting collaborative learning.

Indeterminacy and risk were also present. For example, the relevance of Materials studies might not be immediately apparent from user-centered design or IT development perspectives, since they were made without clear users or applications in mind. While problem-solving was involved, it was targeted at the materials and situation at hand. Neither was there anything very advanced about much of the technology, since initial studies were improvised with off-the-shelf components or pre-existing technical platforms. However, such material experimentation proved fundamental to build collaboration in a cross-disciplinary context. Rather than top-down application of an advanced technical platform, possibilities were generated from combinations of rather basic materials brought by participants from diverse fields, combined in unexpected ways, and further developed through collaborative making.

As resulting samples began accumulating in the studio, they began to be incorporated into a range of other design activities, for example as conceptual or physical props in application development. 'Reach', for instance, adopted and recycled Material studies for ideation and rapid prototyping of concepts for fashion. Use and IT were not, or at least not only, starting points – such possibilities emerged out of doing experimental design together.

Just as Stan Allen uses the term 'speculative' to evoke both notions of theoretical doubt and sleazy land-speculation, our use of the word 'experimental' may evoke images of alchemy and mad science. [10] This is not entirely unreasonable, given the spirit of Material studies. Indeed, experimental action and enquiry aptly describe other projects within IT+Textiles that perhaps deal with other concerns – for example: aesthetic vocabulary (for example, in 'Reach' and 'Fabrication'), acts of use ('Information Deliverer' and 'Draft'), and multimodal expressions (Tic-Tac-Textiles, 'Mute' and 'Sound Hiders'). However mad the method might be, 'experimental design' was fundamental for probing into the relatively unknown design space of IT+Textiles. Such experimentation, for our purposes in the IT+Textiles program, may be likened to a sort of basic research into material expressions that treats 'technology as design material' in both conceptual and practical terms.

Materials before – or for – design

A return to materials, as pursued in IT+Textiles, also returns us to the previous discussion of 'design materials' with a fresh understanding. In 'Material practice', the discussion shifted attention away from questions of use ('How do I make this artifact usable?') and even form ('What is this artifact?') to focus on the materials that enable us to build artifacts in the first place. As applied to a notion of material practice this extended Schön's case for the 'interweaving of thinking and making', such that each fuels and bounds the other in the discovery of complex material behaviors and generation of new combinations. Extending this, we might reflect on relations between the materials used to build form in design and 'design materials' as more generally conceived within research discourse.

Materials
IT+Textiles
Experimental design

In IT+Textiles, primary focus was on materials in themselves. In Materials studies, material combinations and expressions were in focus – however, the diversity and expertise involved in such material practice entailed rather extensive collaboration. Within project work, materials – in and of themselves – were a basis for 'making together'. As such, however, they also took on an additional, representational role, as a vehicle for mutual learning, decision-making, and communicating – much as more general conceptions of 'design materials' are discussed within research into collaborative work. Furthermore, samples resulting from Materials studies took on a life of their own outside the project itself, as 'boundary objects' in other group work or 'raw' materials for new application development. [11] The line begins to blur between practices of tinkering and designing, sketching, and application development – between 'materials for design' and 'design materials'.

Thus, materials served multiple purposes: first, they were the subject of enquiry, as something to 'work into', to discover unexpected expressive possibilities; in practice, they took on an additional function as a medium 'through' which to support something else, that is, collaborative work, and; they continued to have conceptual and practical roles long after 'making' and way beyond the original intent of their creators.

This points to some rather interesting implications. The difference between raw materials and designed things used to be relatively clear-cut. If artisans and engineers might traditionally have been primarily concerned with 'what' a material was, design has typically been concerned with 'what for', with subsequent uses and users in mind. [12] Design involved selection among distinct alternatives within a range of given materials with known material properties, and a focus on function within particular application domains. To some extent, textile design already breaks from such a focus, since the focus is on the form of materials, rather than that of objects that might eventually be designed with them. As Redström notes, "Working with the form of materials rather than the function of objects is not just an educational process

– for instance, a textile designer may work with a material without knowing exactly what purposes it eventually might be used for since this is left open for the whoever decides to use it. Although the textile designer might have ideas about tablecloths, curtains or clothes, what he or she actually designs is the fabric itself." [13]

Such overlap of concerns and roles has already become evident in the discussions of 'Material life' and 'Material practice'. Today, materials and material behaviors are not merely to be discovered in advance of and applied by design, but may be 'made to order', themselves designed at the level of 'atoms and bits'. History is populated with material expressions discovered in and through the applied arts, for example as reinforced concrete and plywood were adopted from industry and further developed for aesthetic and critical purposes by proponents of 'expressionism' and 'D.I.Y.' Taking an experimental design approach in IT+Textiles focused attention on unexpected material combinations and emergent material expressions. We rediscovered traditional, advanced, and off-the-shelf materials, employing a variety of techniques for making. While our focus in projects such as Material studies was on materials in themselves, on generating and varying expressions, there was also overlap with issues of use and users as ideas were prompted within the experimental process, and long after.

IT+Textiles illustrates how the line between 'design materials' and 'materials for design' blurs, since there may not be a clear point at which 'materials' become 'materials for'. Further, considering practice as experimental action, in which thinking and doing are interwoven, the distinction between how we might 'work into' and work 'through' materials also begins to blur. However, even as various familiar notions begin to blur, it is still important to make certain distinctions. Even when materials are not given in advance, as in those made to order, or when they are designed with no explicit application in mind, 'what' characterizes a material must be understood apart from 'how' it might be combined with others to build up particular forms. Rather than merely 'finishing' a concept or 'packaging' technology, technological and traditional materials might be combined in unconventional ways and together treated as starting points for design research.

Materials
IT+Textiles
Experimental design

Reflections on material practice

Three issues were drawn out in 'Material practice' to frame the problematics discussed in 'Material life' – 'abstraction', 'expressions', and 'formation' framed a discussion of the particular challenges of thinking about and working with technology in design. These are extended here to loosely frame some reflections on 'Material studies', 'Reach', and 'Tic-Tac-Textiles'. This is done retrospectively, of course, upon a program and projects with particular concerns and conditions that circumscribed their original conception and progress. Thus, reflections are exposed as afterthoughts and speculations that are left open-ended, which may resonate with topics discussed in other sections of this text or as threads for future development.

Abstraction

A central issue in discussions of the progression from craft to design practice is the spatial and temporal remove from materials. The abstract logics of computation have meant that design is often directed at representing, rather than working directly with, the complexity of technological objects. However, as discussed, besides design as 'packaging', there are other ways to consider the basic materiality of technologies. Nevertheless, practice is increasingly mediated by abstract systems of representation such as drawings, models, and simulations – that is, by a range of other 'design materials' in addition to, or instead of, materials themselves. Despite the abstraction of technologies and of contemporary design practice, approaches to material practice indicate some scope for engaging with technologies at various levels of complexity, as a basis for experimenting with the spatial and temporal variables of new materials.

Given the multi-disciplinary character of IT+Textiles, we considered how to frame conceptual and practical engagement with diverse materials on a collaborative basis. Located at the intersection of two rather disparate domains, a variety of disciplinary techniques, methods, and conditions were involved. Rather than attempting to converge into a common practice, the idea was to engage the diverse expertise and deep knowledge of various practitioners, to create a forum where differences might be drawn out, openly and personally negotiated in the course of practical project work.

Our focus was not on everyone learning the working methods or theoretical foundations respective to different domains, but on formats for engaging conceptually and making together. Since joining disciplines at a programmatic level inevitably multiplied the specialized and abstract technical and representational systems that might be involved, it was important that the scope and depth of expertise be negotiated on an individual and project basis. Outcomes might embody or suggest specialist concerns but, more importantly, represent shared concerns resulting from collaboration. For example, Materials studies combined multiple relatively expert techniques of weaving, knitting and dying, mechanical and electrical engineering. Solo work and individual expertise were essential for probing deeply into different domains, excavating potentials that might be brought into a new context.

However, individual efforts and expertise were also incorporated into collaborative working sessions. For example, 'party textiles' involved on-the-spot 'animation' of separately prepared materials. A range of aesthetic effects emerged by plugging in different sensors, layering fabric combinations, and adjusting software to different speeds or sequences. The materiality of the resulting hybrid samples was, to some extent, the result of give-and-take between expert and collaborative work. Along the way, a range of additional construction and computational techniques were developed. Ultimately, the samples operated as conceptual and practical building blocks for those with different areas of expertise to engage with such materials.

Reach and Tic-Tac-Textiles engaged additional working methods. Reach combined the practical making and hands-on discovery of Materials studies with projective and conceptual methods. Rather than making from scratch, the project drew existing samples into ideation sessions along with less specialized techniques such as sewing and screen-printing. Since the focus was both on material and social expressions, the project incorporated samples alongside paper mock-ups for role-playing use scenarios. In the end, certain existing samples deconstructed and repurposed, and entirely new ones were generated. While some of the final wearable items were resolved as technically-working prototypes, others were conceptual pieces, depicted through representational methods such as photo-scenarios.

Tic-Tac-Textiles quite literally evolved out of disparate working methods – developed as multiple smaller projects were wrapped up into a larger whole. An ethnographic study, Materials studies, and a furniture design study were all incorporated, though developed independently of one another and with respect to rather different concerns. The results of such studies catalyzed the interest of enough people that a larger team drew together to develop the conceptual frames and material expressions as a joint project. Indeed, textile, hardware, software, and furniture components were carefully crafted and resolved together, involving another level of finishing beyond that of the open experimentation of Materials studies or the more conceptual products of Reach. Even technical drawings became necessary to plan furniture construction as well as to contract the external manufacture of a printed circuit.

Each of these three projects explored similar material expressions. However, very different approaches were taken. Materials studies literally 'work into' textile and technological materials, involving hands-on experimentation and particular disciplinary expertise. Reach involves more generalized techniques for making, situating collaborative work around accessible and impromptu scenario-based methods. In each, low- or hi-fidelity animation played an important role in working together – for exploring temporal effects in Materials studies and social dynamics of use in Reach. Tic-Tac-Textiles involved additional methods more typical to user-centered and product design – material expressions and animation were still central but focused on crafting material expressions for particular interactions in use. Within the same basic material expressions, different potentials were developed according to different areas of interest and range of expertise in each project.

It was important that materials themselves were the basis for conceptual and practical work – additional 'design materials' were involved, but as supplements to early investigations or collaborative work. Even the fact that fabrics, sensors, fibers, and samples had a strong presence around the studio supported a significant conceptual and practical presence in project work. Just as specialized textile techniques were materialized in the samples, the abstraction of computational, sensing, and communication processes could also be easily demonstrated – spatial and temporal expressions were thus available to be explored and repurposed, hacked and patched. This provided a basis for all participants to engage perceptibly and communicate with one another about the parameters involved, sketching ideas and animating alternatives directly. Such interactions, with materials as a conceptual and practical basis, drove creative and social processes at individual, project, and programmatic levels.

Afterthoughts

Combining diverse traditions, methods, and techniques opened up possibilities and problematics with respect to material practice, but also exposed certain difficulties in multi-disciplinary work. Inevitably, the outcomes were valued and represented differently by different people. While a textile designer might discover new technical

Speculations

How might adopting and subverting existing prototyping platforms provide an alternative or complementary option, rather than everyone having to gain deep technical knowledge and skills? Is such activity a form of (re-)production or research in itself?

How to balance the role of design materials and formal representations, design methods and documentation, alongside a more basic need to 'work into' and understand materials in and of themselves?

In a program driven by strong individuals from diverse disciplines, how to set and maintain formats for exposing, negotiating, and decision-making with respect to different working methods and evolving concerns?

In multi-disciplinary and collaborative practice-led research, in which research process and design process are closely intertwined, how might individual roles and collective interests need to be considered differently?

possibilities, an electrical engineer might need new techniques to work with new materials – within the same project and based on the same artifacts, each might develop different theoretical or conceptual possibilities. This is evident in the significant range and depth of impact achieved by projects in diverse domains – including advanced textiles, product development, design methods, and ubiquitous computing. Lines of enquiry continued long after the project on diverse bases – for example, two textile designers involved became PhD students, a spin-off company launched, and two educational curricula were developed.

However, we also discovered other more difficult issues in our attempt at something between the open-endedness of individual-driven academic research and highly-managed design processes. Not only were we trying to maintain diversity internally but the program operated at an intersection of diverse domains externally – boundary and identity issues on the programmatic level proved challenging to establish and maintain. For one thing, authorship, ownership, and reputation are treated rather differently in different domains. For example, individuality is highly prized in textile design and doctoral research, whereas collective definitions are perhaps more common in commercial design and IT development – not to mention differences in publishing accreditation and intellectual property. In some cases, differences have translated as mixed messages – particularly as results extended well after the program ended and were carried on by individuals.

In addition to differences in internal and external perceptions, certain disciplinary and personal dynamics played out in projects. While the intention was to avoid conventions in which technical expertise might be reduced to IT support and design to packaging, it was up to participants to communicate and negotiate their own research interests and practical capabilities. Additionally, in the course of practical work, participants also had to carry out conventional implementation roles. While interests and roles had to be considered differently than in conventional design work, research and implementation processes were so intertwined that it proved difficult to distinguish and maintain priorities. This was another dynamic to multi-disciplinary collaboration that was difficult to anticipate or manage since such challenges were experienced differently by various participants and valued differently within projects.

Expressions

Materials science and computer science increasingly overlap in knowledge and techniques for manipulating matter at very basic levels. On one hand, it becomes possible for designers to specify performances to extreme precision and to zoom into micro- and macro-scopic views using new design tools. On the other hand, there are established and emerging approaches to material practice within the applied arts. While such practitioners may be savvy with respect to new materials and tools, these are not seen merely in instrumental or functional terms, which might obscure primary concern with aesthetic and critical implications of the materials themselves. Increasingly sophisticated design techniques and renewed interest in material traditions both serve to expand and diversify the 'open catalog of techniques'.

In IT+Textiles, it was not our intention to turn into materials scientists or artisans. However, we did want to probe into scientific advances and traditional modes of practice. While certainly issues of technique and skill were present, our focus was not on optimizing tools or ease-of-use, a concern for which might well diverge across different disciplines. 'Technology as design material' as a theme framed a space where issues of functionality, utility, usability, and application were involved, but taken up as related to more central notions of material expressions.

Certainly, different projects approached such issues differently. Reach took social situations, emotional values, and patterns of human interaction as starting points alongside material expressions – other projects not presented here, such as the 'Interactive Pillows', even more explicitly combined user-centered with experimental design. In Tic-Tac-Textiles, use was in focus, but not in terms of usability. Indeed, one starting point was the time-consuming waiting that accompanies technology use. Rather than approaching this as a problem to be solved, the aesthetics of in-between and downtime were explored. Slow play, coffee-break respite, and social exchange were alternatives to values of 'speed', 'efficiency', or 'transparency'. A focus on material expressions shifted attention to basic aesthetic and temporal qualities, expanding a design space within which issues of use could be (re-)engaged.

Certain material expressions are common to all three projects described here, though use and users were treated differently. Materials studies probed into qualities of light and heat layered into spatially- and temporally-nuanced expressions. A party theme was taken up to elaborate on subtle and overlapping behaviors that might gradually emerge over the course of single dinner-party event or over the entire winter-holiday season. In Reach, similar expressions were applied to the dynamics of public space, personal expression, and fashion culture – electroluminescent patterns of the 'Reach in bag' dramatically mirror conversation. Material variations were still important – for example, techniques for effecting addition, subtraction, and animation of textile patterns, and techniques for sensing changes in bodily or environmental states.

In addition, Reach intersects a set of material expressions with a set of potential social interactions, such as conversation, exchange, and personal expression. Other sets of logical principles were introduced – typical social interactions and fashion accessories – as additional bases for mix-and-matching. Material expressions, social behaviors, and fashion applications were combined as a platform for expressions to emerge – in use. For example, the type of pattern and rate of change in the two 'Reach out hats' might reflect or provoke a social exchange in use, as a non-verbal vocabulary of expression. If Materials studies are a palette of material expressions, which might then be available for design, Reach takes these as a platform for building another, meta-level palette of interpersonal expressions in use.

In Tic-Tac-Textiles, the scale of expressions was expanded, both spatially and as engaged over time in use. As in other examples, thermochromic materials, environmental sensing, and information exchange were basic parameters. In this case, such parameters were kept deliberately simple, seamlessly integrated into familiar things and familiar patterns of interaction. For example, sensing, actuation, and textile materials were carefully crafted as a thin layer in the tabletop and the familiar logic of tic-tac-toe was an infrastructure for the aesthetic and game pattern to unfold. Intentionally discrete, these act as a backdrop to ongoing social and waiting activities, invisible except as triggered in use. Additional variation is introduced by the modular furniture, which accommodates various types of social interaction, extended throughout one or more cafés. If Reach mirrors and amplifies real-time, face-to-face social patterns through dynamic expressions, Tic-Tac-Textiles is a subtle overlay of a new logic into familiar activities, inviting direct sociability or remote exchange.

Within the same basic palette of materials, a diverse range of aesthetic dynamics were explored in each project. Each works on more or less micro- or macro-levels of control. While certainly not basic science or pure craft, Materials studies manage to delve rather deeply variables inherent to two rather different material traditions. Reach mixes up material expressions with another set of patterns from ordinary human interaction. Tic-Tac-Textiles involves rather sophisticated technical solutions

Speculations

If 'material expressions' and 'non-functionality' frame a common ground at a programmatic level, how to deepen and develop – even challenge – these within multi-disciplinary project work?

In relating, but not belonging to, material science or crafts practice, which working methods and concepts might be borrowed or combined?

How might the degree of control over materials or the scope of design issues affect different outcomes?

How to qualify the 'products' of design research, particularly since many established formats of evaluation and dissemination are discipline- or domain-specific? 'Prototype' or 'product', 'example' or 'illustration', 'model' or 'prop'?

and resolved textile design – as material expressions and acts of use are thus tightly integrated, attention is drawn to the interplay between, drawn out by unexpected interactivity and slowness. Each project explores relatively similar material expressions, but reframes the scale of concern and scope of design in relation to respective differences in social, cultural, and environmental factors considered in addition.

Afterthoughts

IT+Textiles operated in between issues relevant to material and computer science, craft and professional design. As evident in the design examples, we shared much with other art, architectural, and craft perspectives, with respect to concerns for aesthetics, materials, the human scale of everyday things, and familiar product genres. However, because technology was central to our agenda, we were still necessarily dealing with associated preoccupations such as functionality and usability. However, in other disciplines such concerns have long since been surpassed by more specific strategies and critical approaches – for example, notions of 'reproduction' and 'deconstruction' developed by some of those discussed in 'Material practice'. Certainly some projects touched on such issues – Reach reinterpreted textile traditions and inserted cultural subtext, and Tic-Tac-Textile enquired into 'use' by distorting utility in multiple ways. However, relating to but operating between the concerns of multiple disciplines created certain difficulties in digging deeply into certain critical issues.

Indeed, viewed from outside, or from the insides of other domains such as art or design, some projects – taken in isolation – might seem to lack originality or criticality. Certainly, there are a lot of similar products that make use of electroluminescent wire, for example. The difference in IT+Textiles is that such projects not only relate to other external projects but are part of building, over several years, a certain critical mass of knowledge and shared experience within the program as a whole. The artifactual 'products' of design research are part of the larger territory and ongoing accumulation of activities within such a program. In fact, we often use the term 'design examples' to position such artifacts in relation to a wider program of research concerns and material practice. However, such distinctions are not easy to grasp in design magazines, art galleries, or trade shows. Confusion arises when projects might seem to relate to issues more deeply developed in other disciplines but are not explicitly positioned or do not engage as deeply, with the danger that they may be easily dismissed before the larger context might be apprehended.

In part, some of our difficulties had to do with the challenges of mapping out a wide and inclusive territory to position an investigation into a relatively unknown design space – which meant that we sacrificed specificity. The program also brought a lot of 'newcomers' to research, diverse partner institutions and strong individuals from diverse disciplines. It was a particular challenge to establish concrete starting points, an experimental mindset, and frames for self-direction. This might be done on a programmatic level, but much was left to project work to develop and communicate more specific perspectives. This simply cannot be mandated from the top-down – our experience is that open structures, personal synergies, and flexible frameworks are more effective in 'preparing the ground' or 'designing the conditions' for new and even profound ideas to emerge from the bottom-up. As any research, experimental design is inherently risky – with as much learned from problems exposed.

Formation

Dynamic performance, rather than static appearance, comes to the fore in new materials. 'Active' materials may interact mechanically, chemically, or computationally as they are combined with others. Material expressions are characterized by both spatial composition and formation in time. Temporal dynamics are inherent, whether

by design or by nature – computation may be one property, among others. Examples in 'Material practice' consider temporality to some extent – for example, weaving synced with biometrics, fashion fabrication by genetic algorithm, scaling microscopic forms, eternal knitting, games of chance, even processes of wear and rust. Such approaches 'work into' or 'tease out' complex and even unexpected behaviors – formation might be said to include processes and products in which materials 'find form', rather than imposition of form upon inert materials.

In IT+Textiles, temporality was explicitly in focus. On one hand, temporal aspects of technologies were investigated in relation to the textured, sensory, and spatial qualities of more traditional materials. Sensing, computation, communication, and actuation processes, for example, were central to material expressions in the slow game of tic-tac-toe and the proximal patterning of 'Reach out hats'. On the other hand, unique properties of spatial materials determined how the temporal dynamics of technologies were given presence. For example, the ways in which inks, weaves, conductive, and actuating materials were constructed together determined the visual and temporal aesthetics of communication in Tic-Tac-Textiles and Reach. Each project explored aspects of temporal dynamics, expressed in the original program as 'the interplay between spatial and temporal gestalt in the design of everyday things'– 'spatial expression of computational processes and temporal structures'.

Materials studies probed deeply into temporal variables in material expressions. Each sample could be animated in various ways, depending on the combination of sensors plugged in and programmed parameters. Multiple temporal conditions could be made to overlap within a single sample – for example, inputs from light sensors may change gradually, while that from a sound sensor might change rapidly and dramatically. Illuminating electroluminescent film or wire may only be 'on/off' – however, when multiple films or wires are integrated in a textile sample with multiple sensors, as in 'party textiles', a complex intertwining of aesthetic effects results, as lighting and fading overlap within a weave or are sequenced over time.

In Reach, temporal qualities mirror and amplify aspects of the social and physical environment. Reach in bags display sound, ranging from slow reflections of general ambiance to vivid rhythms of music or conversation. The range of expressions is determined by the weave and by rules of sound-to-light animation. Thermochromic and electroluminescent materials entail that aesthetic effects are not only consequent on these designed qualities but also on natural conditions – on the temperature differential between one's body and the local surround, and on variable ambient light. Thus, the spatial and temporal form – visual and temporal patterning of the material expression – unfolds in relation to natural and social conditions of use over time.

The temporality of Tic-Tac-Textiles is more subtle and wholly dependent on use. Visually, there is no indication of supplemental interactivity. 'X's and 'o's appear and are exchanged slowly – without hot cups, they do not appear, and without reciprocal action, they are not exchanged. It is not just the temporal form of the design but that of use that makes the game present and sustains it over time. With respect to use, it is the ritual of coffee-drinking that causes the appearance of the game and determines its duration. More specifically, use is mediated by a coffee-cup, the heat of which transfers marks and the lack of heat, indicating an empty or cooling cup, determines when time for game-play has run out. Technically, 'heat' is transferred both spatially and temporally: spatially, through temperature sensors, communication protocols, heat-conductive printed circuits, and thermochromic fabric; temporally, through the time of sensing, processing, transferring, processing, and actuating.

Speculations

How – or whether – to distinguish between the natural temporality intrinsic to any material and a temporal form given by design?

How are material expressions determined by variables in nature, design, or use?

How to consider conventions of 'display' and 'interface', particularly as materials and artifacts interact with one another? Any material inevitably displays aspects of its own state and, to some extent, its history and local surround – are the designed and interactive 'performances' of new materials so different?

How might material expressions affect or mediate relations to our everyday and intimate things that are being transformed by the increasing ubiquity of technology?

How to consider material expressions and temporal form together with the evolution of subjective meanings and cultural values in use?

In these examples, temporality is not explored in and of itself, or in isolation. Instead, it is considered within hybrid material compositions and natural and social conditions of use. Thus, combinations, sequences, and overlaps of traditional and technological materials produce new aesthetic and situated effects. While computational processes may be more or less rapid, by design, a range of other factors are introduced with textile materials and everyday use. Rather than materials explicitly intended for efficient conduction or direct expression, as in the copper used to make electrical wiring or the polymers used to make computer screens, here heat and light are transferred through textile materials, which have entirely different properties. A range of new temporal effects and sensory 'by-products' are introduced, such as slowness, rhythmic variation, residual warmth, and visual traces – together with incidental factors such as the natural surround, local conditions, and social interaction.

Afterthoughts

Enquiring into temporality reveals the intersection of diverse conditions – among them, evolution inherent in materials, the design of temporal form, the composition of material combinations, and the relations among communicating artifacts. Chemistry and computation are two aspects of the complex time characterizing materials. Even within a single material, chemical transformation – whether rust and patina or thermochromicity and electroluminescence – might be considered in relation to the unfolding of computational effects in the short or long term. Materials with different expressions might be combined in a single artifact, and multiple artifacts might be connected together in smart 'systems of objects', co-located or remotely distributed. Further variables include: ambient conditions, such as weather patterns, cycles of night and day or of seasons; social conditions, such as the rhythm of a conversational exchange or patterns of movement, and; interaction, between people, among people and things, and within systems of objects. From the inside out and from the outside in, a range of factors with temporal conditions intertwine and determine one another.

Various aspects of temporality were explored in IT+Textiles. Through hands-on 'experimentation in contact with the real' in Material studies or through their appropriation into other projects, temporal variables were explored in materials, operative techniques, and various situations. Reach set out not only to discover the spatial and temporal expressions of materials within a design situation – but to determine the conditions in which they might emerge in situations of use. Where the Material studies focused more on issues of 'display', manifesting the 'inner workings' of dynamics within materials and material combinations, Reach projected how such display might catalyze certain personal and social dynamics. Thus, the effects of such material expressions in inviting or provoking change in use were explored.

This range of temporal conditions resonates with those discussed in the section on 'event architecture'. Certainly, material artifacts are inherently temporal in their own right, through wear, adaptation, or redesign over time. Allen's notion of 'infrastructure' explores this, as parts are 'both complete and incomplete', field conditions built up out of patches and unoccupied slots – slack is built into the system such that 'they work with time and are open to change'. Irrespective of particular artifacts, Iain Borden delves into aspects of subjective experience, which appropriates 'found space' into the rhythms of embodied action. Bernard Tschumi locates 'events' as the unique occurrences in the friction between these, which are both unpredictable and un-designable. For him, architecture is not about the conditions for design, but the design of conditions such that (mis-)use might take over. Here, our concern must be for both – the materials that precede and situate the conditions for design as a material practice and the design of material conditions for use.

However, treating technology as a material entails additional considerations, since the spatial and temporal conditions of such materials are significantly different from other materials that we are more familiar with. Materials are no longer unambiguously 'a priori', available within nature as a standing reserve, to be discovered by design, and put to use. Even our most familiar materials are neither fully natural nor wholly artificial. New materials expose this since they have become available to design – and enquiry – more explicitly and comprehensively than before. Artifacts may contain complex processes within themselves to an unprecedented degree, rapidly changing and affecting one another through intangible networks of communication and exchange – a 'new artificial' alongside existing natural ecologies and evolving material cultures. In IT+Textiles, we only began to touch upon the expressive and conceptual implications.

Materials may not only act as 'displays' or 'inputs' to local and contained processes of use, but act as interfaces to complex, networked, and ongoing chains of action-reaction-interaction. Object-subject-event dynamics occur at all scales – as touched upon in Reach, interactions occurring at scales of 'atoms and bits' might also effect large artifactual and social systems, perhaps sited and co-located but also potentially mobile and global. Such processes may be independent of us, as in some displays explored in Materials studies that change autonomously – or be entirely dependent on use, as in the interactive exchange in Tic-Tac-Textiles. As discussed in the next sections on 'Use', interactivity involves material conditions, set by design, but also reactions and new (inter)actions. While use itself cannot be designed, nevertheless it may fundamentally change the material conditions of an artifact or system.

Such interactive processes are contingent upon use, as such things become incorporated into intimate lifeworlds and lived with everyday. New temporal dimensions thus come into play, such as rust, patina, and memory, are bound up with cultural and emotional aspects of long-term and widespread use of everyday material things, as will be discussed in later sections on 'Change'. These are aspects we only began to touch upon in IT+Textiles – in fact, our focus on material expressions and computational 'materialization' quite often meant that our focus was on display, in terms of aesthetics, proximate use, and local meanings. Revisiting notions of material practice but in terms of temporality and technology as a design material opens up a range of new dynamics – of materials, systems, and cultures – that might be the basis for further exploration and elaboration in new research programs.

Notes

1 Hallnäs, Redström, and Melin, "A Design Research Program," *Nordic Textile Journal*, 56.

2 See Redström, "Technology as Material," in *IT+Textiles*, ed. Redström, Redström, and Mazé. See also Redström, "On Technology as Material for Design," in *Design Philosophy Papers*, ed. Willis.

3 For more background on the research theme in IT+Textiles and on the project examples presented here see Eriksson, Ernevi, Jacobs, Löfgren, Mazé, Redström, Thoresson, and Worbin, "Tic-Tac-Textiles: A Waiting Game," in *IT+Textiles*; Ernevi, Eriksson, Jacobs, Löfgren, Mazé, Redström, Thoresson, and Worbin, "Tic Tac Textiles," *Proceedings of CUMULUS*; Hallnäs and Redström, *Interaction Design: Foundations, Experiments*; Hallnäs, Melin, and Redström, "Textile Displays," *Proceedings of NordiCHI*; Jacobs and Worbin, "Reach," *Proceedings of CHI*; Landin and Worbin, "Fabrication," *Proceedings of PixelRaiders*; Mazé and Redström, "Form and the Computational Object," *Digital Creativity*; Mazé, "Joining Tradition and Innovation," *Proceedings of ERA*; Melin, Jernström, and Redström, "Interactive Party Textiles," *Proceedings of INTERACT*; Jacobs and Worbin, "Reach: Wearable Patterns," in *IT+Textiles*; Worbin, "Dynamic Textile Pattern" (MA thesis).
For further information and publications on all the projects developed within IT+Textiles see IT+Textiles (webpage).

4 Mills, "Laboratory or Workshop?" in *Pragmatist Imagination*, ed. Ockman, 26.

5 Schön, *Reflective Practitioner,* 280.

6 Glanville, "Researching Design and Designing Research," *Design Issues*, 88, 87.

7 Hallnäs and Redström, *Interaction*, 64.

8 See Pye, *Nature and Art of Workmanship*. Cf. Beardon, Gollifer, Rose, and Worden, "Computer Use by Artists and Designers," in *Computers and Design in Context*, ed. Kyng and Mathiassen.

9 For further information about Smart-Its see: Smart-Its Project (website); Holmquist et al., "Building Intelligent Environments with Smart-Its," *IEEE Computer Graphics*.

10 See Allen, "Its Exercise, Under Certain Conditions," *Columbia Documents*.

11 For relevant discussions of 'boundary objects' see Brown and Duguid, "Borderline Issues: Social and Material," *Human Computer Interaction*; Star, "Structure of Ill-Structured Solutions," *Distributed Artificial Intelligence*.

12 For some discussion of the 'what' in craft and engineering practice see Manzini, *Material of Invention*.

13 Redström, "Technology,"in *IT+Textiles*, 21.

Use

Becoming users

Before there are 'users', there are things and people. Since there cannot be users of things that do not exist, it is 'some thing' that turns people into users. At some point in the process of encountering things, people become users. Then, in the process of being 'used', things become incorporated into our actions and appropriated into everyday life. As Roger Silverstone and Eric Hirsch suggest, "objects and meanings, technologies and media… cross the diffuse and shifting boundaries between the public sphere where they are produced and distributed, and the private sphere where they are appropriated into a personal economy of meaning." [1] Somehow, people become users and things become used and appropriated. We might wonder how this comes about – particularly if we are interested in the role of things in such a process.

There are, of course, various ways of considering the distinction between 'users' and 'consumers' that reflect different conceptions of use. Augusto Morello posits the difference between users and consumers – 'homo faber' and 'homo oeconomicus' – as that between 'someone who uses' and 'someone who chooses for use'. [2] In his argument, both consumers and users are concerned with use, for example with efficacy and efficiency, but in different ways. Where a consumer chooses once for every possible occasion of use in the future, a user engages in multiple occasions of use. Use might be seen as sort of 'microproject' of consumption, involving repeated and specific instantiations of the original choice to consume, and thus increased and ongoing commitment.

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We might then wonder about how things in themselves might factor into macro- and micro-projects of people's everyday lives. Serge Tisseron, a psychoanalyst concerned with psychic and emotional relations to things, in addition to practical and symbolic roles, argues:

> Objects are for us, often without our recognizing it, the companions of our actions, our emotions and our thoughts. They not only accompany us from the cradle to the grave. They precede us in the one and survive us in the other. Tomorrow they will speak our language. But are they not already speaking to us, and sometimes much better than with words? [3]

Objects are inseparable from our practical actions as they are from our everyday life and ways of being. In instrumental terms, things make the world amenable to our actions – as they are given or made, we take them up in order to achieve certain ends. Indeed, we may not even recognize how embedded they our in our life-worlds, the extent to which they are incorporated into our patterns of action or how they determine our interactions with others. We might consider how such things 'accompany' our actions, emotions, and thoughts, even 'speaking our language'. That is to say, we might consider that they are *designed* to do so.

The design of objects persuades us into action. In quite basic ways – so basic that we might not even recognize it – objects require us to act in particular ways, even changing from one way of acting to another. For example, Wim Gilles, one of the first industrial designers, once commented: "We are not made to sit in chairs. You are supposed to squat on your haunches on the ground. A chair is a cultural thing. You have to learn to sit. There is not a single chair that is ergonomically sound." [4] Certainly, the act of sitting and the design of chairs have become closely associated. This association is one both of proximate use, incorporation into habit, and, eventually, cultural convention and design practice. Objects, by design, invite us to enter into consumption and into becoming users.

Insides and outsides

To better understand how objects invite our action, we might consider some perspectives and examples. For instance, Richard Buchanan argues for the persuasive power of spatial form. Through "vivid expression" in spatial form, aspects of "technological reasoning" are made explicit and "apparent at a glance", along with the expression of "ethos" and "emotional persuasion." In use, "Much feeling is conveyed in the experience of movement, whether in the gestures made in using an object or in the shift of visual attention across its lines, colors and patterns. This is what makes the emotive argument of a design so powerful and persuasive: it collapses the distance between the object and the minds of the users." [5] Engaging our bodies, minds, and emotions, spatial form makes the possibilities of things amenable to our perception and action.

However, not all aspects of things are directly available to perception immediately or completely. Buchanan describes engagement as including both physical contact with and "active contemplation" of objects before, during, and after use. In Buchanan's analysis, he examines the differences between two dividers, which are simple mechanical devices used for drawing. In each, the potential for moving and revolving various parts – or, in his words, the 'technological reasoning' – is made more or less explicit. In one of the devices, relationships among the parts were visually apparent, whereas the other required physical handling to understand how it works. Technological reasoning may be more or less available through visual and tactile means. In some objects, it is only in use that such technological reasoning and design intentions become available as possibilities for interaction.

Since technological objects require some kind of spatially manifest means for users to perceive and interact with them, much attention has been paid to studying the significance of spatial form. For example, product semiotics and semantics grew out of communication theory and, later, cultural studies to focus on the construction of meaning in and through artifacts. Physical, graphical, and other qualities are studied in terms of meanings and functions that might be signified. Concepts such as signs, iconography, indexicality, symbolism, metaphor, and codes are employed to describe how design intention might be conveyed by design and thus afforded in use. As objects have become more technically complex, it has become increasingly difficult to express the inner workings and 'technological reasoning' of machines directly or literally. Such concepts have thus been extended to the design of representations, to 'interfaces' between technology and use.

Consider another example borrowed from Klaus Krippendorff, an industrial designer and early theoretician of product semantics:

> The Xerox photocopying machine designed at RichardsonSmith is a good example. The surface can be handled with desk-top metaphors for paperwork. Opening it allows users to see paperflows and enables them to fix simple processing errors. Further penetration is reserved for qualified repair persons and the final layer for engineers. [6]

The technological reasoning of the photocopier is made apparent in use, to different users, through direct or representational means. Physics and mechanics may directly determine why certain parts are located in relation to others, for instance to enable paper to be moved through. Printed icons on the surface of the machine or options in the LCD 'user interface' are representations, signaling both how the machine works and how people must act in order to use it successfully. In such an object, a variety

Computational processes are executed only over time – just as temporal form unfolds through interaction in use. We might compare this to the backsides of spatial objects – buildings, for example, require us to move not just through space but over time in order that their form becomes more fully available to our senses and, by extension, for us to act upon. Technological objects rely not just on the decision to engage as a consumer, nor a discrete or even repeated act of use. Temporal form requires interaction in order to make aspects of the object available to be used. Such objects may invite us to become consumers or even persuade us into becoming users. However, in order for quite fundamental aspects of their functionality and their form to become available, technological objects require interaction.

It is, of course, no accident that the term 'interaction' – traditionally used to describe human and social behavior – has made its way into Human-Computer Interaction and interaction design. Such frames of reference have been significant in an attempt to achieve the heralded 'dialog between man and machine'. With the shift from mechanical to information technologies, Suchman notes, "the means for controlling computing machines and the behavior that results are increasingly linguistic, rather than mechanistic. That is to say, machine operation becomes less a matter of pushing buttons or pulling levers with some physical result, and more a matter of specifying operations and assessing their effects through the use of a common language… to employ terms borrowed from the description of human interaction – dialogue, conversation and so forth." [9] Indeed, Tisseron's notion of objects that 'speak our language', bridging between the inner psychic world and outer social context, was not just an allusion to the communicative power of form but to artificial intelligence.

The roots of the term 'interaction' in the domain of human and social behavior is significant in multiple respects. First, traditional forms of human interaction such as dialog and conversation are explicitly temporal in nature. Even as spatial form is central both to the discipline of design and to perception and action in use, the design of technological objects involves a fundamental shift to conceive of use in terms of time. To better understand the design of interaction with respect to temporal form, we might revisit certain themes from the study of ordinary human interaction, as situated in the world and in social and cultural practices.

Second, the use of technological things evades simplistic notions of determinism and consumption. Regardless of how persuasive or well-designed something is, ultimately 'becoming users' cannot be determined by design. The choice made at point-of-purchase to become a consumer does not account for the commitment and ongoing choices involved in use. Technological objects, in particular, not only invite but require use such that their possibilities become available to act upon. This suggests that people become not just consumers, nor even mere users, but active participants in evolving interaction.

In the following sections, approaches to interaction informed by sociology, drama, and phenomenology are considered. Returning to notions of action and embodiment, relations among people and things over time are thus reconsidered. These perspectives illustrate that meaning and intentionality cannot be presumed nor ever completely known, rather it emerges from sequences of interaction and repeated encounters, as a practical and ongoing achievement. Thus, we shift from considering how to know what use might be like or how to communicate possible uses, to considering things in use, things that change and endure through and because of use. Interaction might be understood as an ongoing achievement of both design and use, negotiated in context, at a cultural scale, and over time.

The 'meeting' between design and use becomes increasingly complex with respect to technological objects. 'Technological reasoning' expands dramatically with increasing mechanical and computational complexity. Mediating between concern for the engineering and science of the 'inside' and for a user's experience of the 'outside' of an object, the interface between becomes increasingly important. Rather than a matter of directly expressing the technological reasoning or inner workings of an object, it involves abstractions and representations that connect a world of electronic phen-omena and digital logics to that of human perception and action.

Since the inner workings of technological objects are characteristically – even primarily – temporal in nature, a consideration of how the 'inside' and 'outside' meet in the user interface involves both the design of spatial and temporal aspects. Clearly, it is not enough that such an object is made to work, it must also reveal the ways in which it may be used, and operational possibilities may not be immediately or directly available only by means of spatial form. To the extent that a technological object involves computation, its workings involve processes that extend over time. To the extent that it is used, it must relate spatially and temporally to human activities and contexts of use. To the extent that users might intervene to change or redirect computational processes, their own time frames determine the temporality of use. Thus, a variety of temporal conditions characterize interaction.

Interaction is an intertwining not just of embodied actions and spatial forms but of various temporal processes. Possibilities inside the object become available outside only as computational processes meet processes of use in unfolding interaction. Since aspects of a technological object may not be completely or immediately available to use, how these unfold through interaction becomes central. It is through interaction over time that a user discovers the possibilities latent in the object, unfolding options through their own actions. Through interaction, they develop an understanding of the consequences of their actions on the object, and their ability to pursue or achieve certain objectives. Their actions and objectives, however, do not only relate to the object at hand but to circumstances and situations of use.

In addition to 'active contemplation' before, during, and after each encounter in use, we also might think in terms of situated and embodied action. Particularly since technological objects persist in time and use occupies our time, patterns of interaction that involve both computational and human behaviors are personally, socially, and culturally constituted. Terry Winograd and Fernando Flores argue, "Knowledge and understanding (in both the cognitive and linguistic senses) do not result from formal operations on mental representations of an objectively existing world. Rather, they arise from the individual's committed participation in mutually oriented patterns of behavior that are embedded in a socially shared background of concerns, actions and beliefs. This shift from an individual to a social perspective – from mental representation to patterned interaction – permits language and cognition to merge." [10]

Use, thus, cannot be reduced to discrete acts of perception and interpretation, nor design to static models and representations. Instead, we must consider other notions of interaction in order to gain a perspective on the extent to which it might be co-determined by design and use, maintained throughout sequences of interaction, sustained by repeat encounters, incorporated personally and socially over time.

From plan to action

To consider the social and situated nature of action and interaction, Suchman offers a perspective based on communication and an ethnographic approach. To move away from understanding technological objects in spatial terms to the temporal terms of computation and interaction, we might consider her examination of ordinary dialog and conversation. For example, ordinary conversation unfolds through sequences and rhythms of exchange over time. Its distinguishing feature is turn-taking – "the local, moment-by-moment management of the distribution of turns, of their size, and of what gets done in them." [11] Drawing parallels from traditional forms of social and situated human interaction to human-machine interaction, she draws implications for how such forms might be built up, negotiated, and sustained over time.

Conversation does not depend on predetermined plans or rote performance of scripts – in fact, Suchman posits that "plans are best viewed as a weak resource for what is primarily ad hoc activity." [12] For example, she describes the joint production of sentences, the role of silence, and the negotiation of ambiguity. Turn-taking, thus, is a collaborative achievement, relying more on the social and situated dynamics of interaction than on established rules of behavior, transparency of intent, or mutual intelligibility. According to Emanuel Schlegoff, "If certain stable forms appear to emerge or recur in talk, they should be understood as an orderliness wrestled by the participants from interactional contingency, rather than as automatic products of standardized plans. Form, one might say, is also the distillate of action and interaction, not only its blueprint. If that is so, then the description of forms of behavior, forms of discourse… included, has to include interaction among their constitutive domains, and not just as the stage on which scripts written in the mind are played out." [13]

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Similarly, Brenda Laurel complicates notions of interaction as linear or standardized communication. Where Suchman examines ordinary interactions in everyday life, Laurel explores the domain of theater – hence, their approaches have respective differences in notions of intent, purpose, constraints, and duration. Laurel's approach is concerned with enactment and agency in immersive experience, such that people might lose themselves in imaginative 'suspension of disbelief'. Such engagement is achieved through the direction of temporal flow and plot action, for example through condensation, intensification, reversals, and closure. Her classical account of plot (drawn from Aristotle) is based on a 'whole action', or a coherent and causal progression from a range of possibilities, to increasingly certain probabilities, and, finally, to clear necessity. In interactive media, multiple and overlapping whole actions may be possible, each maintaining progression from possibility to probability to necessity.

Laurel shifts emphasis from interface to action. She outlines the traditional notion of a computer interface, that of a person separated from a computer through an interface, in which each somehow operates in relation to 'mental models' of the other's models, and so on, in a dizzying chain of logic and signification. In theater, everything is understood to be a part of a clearly bounded domain in which "the representation is all there is." As taken into human-computer interaction, this suggests that technical logics and mental models behind things are less important, even forgotten, as action and performance become primary. The task of design involves making the experience of action as immersive as possible – even external phenomena such as power outages and error messages should be somehow anticipated and avoided. As she puts it, "The key to applying the notion of 'willing suspension of disbelief' to representational activities that have real-world artifacts is to ensure that the likelihood of unintentional effects on those artifacts approaches zero." [14]

Suchman and Laurel each develop perspectives on how action unfolds over time.

In Laurel's notion of theater, users accept and become complicit with a world of representations. Rather than anticipating or determining mental models, she focuses on constructing a separate and clearly bounded experience within which meaning and action could unfold. Suchman takes a different approach to the relatively unbounded domain of human interaction. She draws on an extensive body of work in 'speech act theory', which shifts away from understanding language as description to language as action, emphasizing the act of language rather than its representational role. [15] Thus, she focuses not on discrete elements or specific meanings but the construction of conversation over time through 'acts', 'actions', and 'interaction'.

While each approach relates to different temporal forms – narrative or conversation, both Suchman and Laurel develop an understanding of how forms are built up over time in use – form as a 'distillate of action and interaction', to recall Schlegoff's words, 'orderliness wrestled by participants from interactional contingency'.

Ob-jects in action

Like Suchman and Laurel, Paul Dourish counters overly cognitive accounts of interaction through notions of action and embodiment. In traditional approaches, it is through mental models 'encoded' in our heads that we recognize things in the world. Instead, Dourish draws from phenomenology to suggest that the world is already filled with meaningful things and that meaning is in fact uncovered and created as people encounter, interpret, and sustain meaning through ongoing interactions in the world and with each other. Such a phenomenological account effectively shifts from an epistemological concern with knowledge to an ontological concern with existence – instead of asking how we know about the world, Heidegger asked about how the world reveals itself to us through ordinary and ongoing encounters. Thus, like Suchman, Dourish develops a perspective on interaction arising out of social, situated, and embodied factors, rather than a rigid or pre-determined plan. [16]

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Heidegger's notion of 'breakdown' is employed in several of these accounts as a basis for describing how people become aware of things and their constraints and possibilities for action. As something is 'ready-to-hand', it is incorporated smoothly and invisibly into practical action – it is only as something becomes unwieldy, broken, or otherwise unavailable that we become aware of the thing in itself and our expectations of it. Dourish uses the example of his computer mouse – as it shifts from being 'ready-to-hand' to being 'present-at-hand' at the edge of the mousepad – to point out how its presence and role become apparent through breakdowns in practical action. In fact, only by impeding our intentional action does something become an 'ob-ject' – or 'that which stands against' – at all.

In revealing the limits of action and 'ob-ject'-ness of things, breakdowns may play different roles in interaction. In Laurel's immersive engagement, breakdowns are to be avoided since they violate the boundaries of a pervasively representational world. Suchman discusses breakdowns to point out that plans and procedures cannot be absolute nor planned in advance. Rules and other such boundaries to action may be intended by design and even incorporated tacitly in use by relating to typical patterns characterizing similar situations and actions. However, their interpretation is particular and circumstantial, as revealed in breakdowns. Winograd and Flores note that, in fact, breakdowns serve an extremely important function in revealing to us the nature of our practices and things. They argue that "the objects and properties that constitute the domain of action for a person are those that emerge in breakdown." [17]

These accounts suggest that it is through interaction that plans and expectations within objects and within use are exposed and, indeed, reconstituted. If meaning

and even 'ob-jects' in the world arise out of ongoing encounters, practical action, and occasioned interactions, then breakdowns may have an important role in exposing their construction. In breakdowns, we become aware of things in themselves, and their role in and constraints on our domain of action. Thus, they become available for interpretation – or, more precisely, inevitable re-interpretation with respect to actions within the unique circumstances of a situation at hand. Hence, we might understand rules, plans and procedures to be a consequence – not just a cause – of the fact that people choose to follow and thus sustain them.

An interactional problem

Suchman's ideas are pervasive in HCI – for instance, in Gregory Abowd, Elizabeth Mynatt, and Tom Rodden's argument that "Ubicomp's efforts informed by a situation action also emphasize improvisational behavior and would not require, or anticipate, the user to follow a predefined script." [18] However, Dourish points out that many still treat things as a 'representational problem' rather than an 'interactional problem'.

As a 'representational problem', ordinary artifacts and actions become things that might be treated as information, to be identified and encoded objectively, in advance and apart from activity. For example, familiar objects and conversational patterns, as taken into system design, become metaphors and models, rather than as the essentially relational, ad-hoc, and social phenomena as they are in the real world. This can be seen, for example, as the 'desktop' metaphor or 'dialogs' in computer software. Such metaphors and models are neither completely natural nor explicitly unnatural, but constitute yet another system of spatial and temporal relations. It is users who must adapt and 'naturalize' these additional representational systems into their ongoing work and social practices.

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In such approaches, not only is it assumed that the real world might be taken into computational systems as representations, but that computational operations might be applied to specify and regulate human behavior. Not only have computational models, but the mental models of people using them have come into the purview of system development. Dourish points out that cognitive science and artificial intelligence have traditionally assumed an analogy between how mental phenomena and computation work. Thus, systems have been developed based on step-by-step temporal models, whether executed by algorithms or procedures. Similarly, he notes, "HCI, from its very beginning, took on the trappings of the traditional computational model and set out its account of the world in terms of plans, procedures, tasks, and goals." [19] However, accounts of interaction from sociological and phenomenological perspectives challenge such static and prescriptive accounts.

As an 'interactional problem', real-world phenomena might be understood to be constituted through embodiment and action. Instead of reducible to information or transposable to models, things are seen as ongoing achievements. Through encounters with things in practical situations of use and even in breakdowns, the parameters of objects are exposed along with the domain of our actions in relation to them. As Dourish puts it, "Context isn't just 'there' but is actively produced, maintained and enacted in the course of the activity at hand." [20] Thus, the forms of objects and interactions cannot be conceived merely in terms of predetermined rule-sets, static forms, or collections of information. As they emerge, are sustained, or even changed within situated activity, such things might be better seen as achievements of ongoing use in personal, social, and cultural terms.

A phenomenological approach would not seek to fix plans and forms or consider these to be independent or given in advance of people's actions and interactions.

The importance of an object is not what it represents or even what it is, but the role that it plays in action, and the ways that it is engaged and sustained in processes of use. While things are to some extent constructed in advance by design, they are also – and significantly – re-constructed and even reconfigured in use as people continually encounter, incorporate, and reinterpret courses of action available through them. Thus, as Dourish puts it, "Embodiment denotes a form of participative status." [21]

Relations between the 'inside' and the 'outside' of a technological object are not fully or finally determined by design. As Tisseron argues, the meanings of things in use are not fixed, stable, or even completely rational – instead, they may change and contradict one another, involving negotiation within personal and cultural practices. As in phenomenological accounts, interaction is not just a mental model or cognitive process. Meanings, reactions, and subsequent actions are determined locally, contingent upon embodied action in personal and social situations of use. If embodiment denotes a form of participative status in interpreting and sustaining objects in use over time, then technological objects involve committed participation. Such commitment must be sustained throughout discrete and repeat acts of interaction, in multiple and changeable situations of use and social circumstances.

Consider Madeline Akrich's perspective on the design determinism versus the social construction of objects, which is further expanded upon in the sections on 'Change':

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> We also have to move between the inside and the outside of technical objects. If we do this, two vital questions start to come into focus. The first has to do with the extent to which the composition of a technical object constrains actants in the way they relate both to the object and to one another. The second concerns the character of these actants and their links, the extent to which they are able to reshape the object, and the various ways in which the object may be used. Once considered in this way, the boundary between the inside and the outside of an object comes to be seen as a consequence of such interaction rather than something that determines it. [22]

To some extent – and at least at initially – the form of objects and interaction are matters of design. Things may be designed to invite or inhibit, open or constrain, expose or hide, aspects on the 'inside' to awareness, interpretation, and action on the 'outside'. To the extent that an understanding of form is basic to design, it becomes essential to consider how spatial and temporal form may accommodate participation, such that objects may become meaningful in use and sustained over time. While such concerns may underlie many general approaches to design theory and practice, the challenges of designing technological objects bring such issues to the fore, since 'becoming users' entails not only consumption and use, but commitment to complex interaction and ongoing participation in unfolding the form of things.

To examine such issues, we might consider examples in which spatial and temporal patterns of anticipated and even unforeseen use are particularly in focus in design. For instance, architecture and urbanism present a range of approaches not just to top-down design or master plans but examples of bottom-up, collective, and continually contested spatial and temporal forms. Notions of 'vernacular' in architecture, in particular, deal explicitly with cultural and local determination over the built environment, revealing notions of use as formation and design as intervention.

Vernacular architecture

Architectural objects are particularly resistant to the passage of time. Unlike other modes of production, architecture is simply not capable of rapid or mass replacement and repetition – the simple fact that buildings are embedded in the ground retards cycles of production and consumption. Therefore, the persistence or obsolescence of architectural objects is particularly significant, standing out as points of intensity or decline in the fabric of the city. In architectural discourse and practice, thus, there are a range of perspectives on use conceived in both spatial and temporal scales.

'Vernacular' forms are those generated and evolved locally. Rather than completely constituted or given in advance, vernaculars grow, evolve, and even disappear over time, dependant upon contexts and cultures of use. Use, in collective and cumulative terms, becomes a determining cultural force. While understanding such spatial and temporal scales of use might require some historical and analytic perspective, vernacular as treated here does not refer merely to regional particularity or techtonic traditions. Rather, it situates design term of intervention into preexisting and ongoing built and cultural environments. Such a notion frames form and use not just in relation to particular places or spatial conventions, but in relation to time.

The word 'vernacular' typically refers to the native language of a country or locality. In linguistic history, it refers to the emergence of vocabularies and grammatical forms distinct from, even opposed to, an 'official' language such as Latin. In architecture, the term first began to be used after the American Civil War, when people began to self-consciously invent a culture to go along with the nation. The notion again gained currency in the 1960s with a rediscovery of locality, pluralism, and populism in many cultural domains. Social scientists, historians, and architects studied the evolution and adaptation of 'essential', 'native', or 'traditional' forms. For example, Bernard Rudofsky surveyed 'Architecture without Architects' worldwide, Philippe Boudon analyzed post-hoc renovations by inhabitants of Le Corbusier's Pessac housing, Stuart Brand examined building techniques native to the Americas, and Christopher Alexander compiled a general pattern language of spatial forms. [23]

To some extent, vernacular signals a more general analytic or archeological move in architecture, focused on study of the given and the existing. For example, the debate in the 1960s between the 'neo-rationalists' (such as Aldo Rossi) and 'neo-realists' (such as Robert Venturi and Denise Scott Brown) took contrasting positions in this respect. [24] Generally speaking, the neo-rationalists insisted on the autonomy of architecture, with a basis in a 'language' of architectural form transcending history and culture, while neo-realists typically looked to external cultural sources such as advertising, art, and cinema. Neo-rationalists and neo-realists argued on behalf of different roles for architecture – whether to provide continuity or express the spirit of the time; whether to be universally accessible or contextual to particular identities; whether to educate and enlighten the public or to serve and propagate the status quo. This debate and its proponents took context, convention, and change, the concerns of vernacular architecture, into wider architectural discourse and into practice.

Convention

Besides merely studying 'what is' – forms found in history, local practices, or socio-cultural patterns – implications of vernacular were also taken into practice. For example, the 'commercial vernacular' of ordinary American suburban development inspired Venturi, Scott Brown, and Steven Izenour. In Aldo Rossi's approach, 'typology' was posited as a canon of essential forms qualified as such by historical persistence and ongoing relevance. While these practitioners were influenced by

various analyses and studies, perhaps even incorporating such methods within their modes of practice, they were essentially concerned with what such understanding might mean as a basis for design intervention. Subsequent positions, such as Rem Koolhaas' contemporary critique of commercial vernacular and typology with respect to 'Bigness', expose wider implications in theoretical discourse as well as reflections on built examples. By delving more deeply into such notions, insights surface with respect to the complex dynamic between form and use and the role of the designer in relating to the spatial and temporal scales of context and culture.

The ordinary

In reaction to modernism's universalizing tendencies in method (mass-production) and aesthetic (the 'International Style'), various postmodern positions were based on the discovery of 'new' pasts and local culture. For example, Venturi, Scott Brown, and Izenour wrote 'Learning From Las Vegas' in 1972, 'mining the strip' to reveal an alternate visual and urban aesthetic. This work was rooted in pop culture and populist planning. Pop infused the London milieu where Scott Brown trained and her later move to the USA coincided with social planning efforts such as Herbert Gans' populism and Paul Davidoff's 'advocacy planning'. Juxtaposing popular and historical references constituted a subversive strategy, along the lines of Venturi's early approach to architectural parody that made explicit the paradoxes and provisionality of a historical moment. Raising such grassroots and popular phenomena to architectural iconicity posed an explicit critique of traditional and mainstream architecture.

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Such currents infused their scenographic and sloganistic exposé on the buildings and billboards along the Las Vegas strip. Their main proclamation reads:

> We shall emphasize image – image over process or form – in asserting that architecture depends in its perception and creation on past experiences and emotional associations and that these symbolic and representational elements may often be contradictory to the form, structure and program with which they combine in the same building. We shall survey this contradiction in its two main manifestations: 1. Where architectural systems of space, structure and program are submerged and distorted by an overall symbolic form. This kind of building-become-sculpture we call the duck… 2. Where systems of space and structure are directly at the service of program, and ornament is applied independently of them. This we call the decorated shed. [25]

In contrast to the modernist 'duck' – architecture as the direct expression of form, structure, and program – their study of Las Vegas reveals a near-ubiquity of decorated sheds – low-cost boxes with huge signs and superficial, iconographic imagery. Their own design for 'Guild House' adopts this self-proclaimed "ugly or ordinary", though a sculptural TV-antenna on the roof was later removed as it was perceived to be making a joke at the expense of the elderly inhabitants and their habits. [26]

'Learning from Las Vegas' sparked a vivid debate. Tomás Maldonado responded: "There is also a kind of cultural nihilism which, consciously or unconsciously, exalts the status quo. We find an example of it among those who are singing paens to die 'landscape' of certain American cities, which are among the most brutal, degrading, and corrupt that consumer society has ever created... Las Vegas is not a creation by the people but for the people. It is the final product... of more than half a century of masked manipulatory violence." [27] The debate split along the lines of elitist versus populist: those condemning commodity culture as mass-media manipulation of the public versus those rejecting the determinacy of technology but finding in pop culture impulses of a new and legitimate grassroots order.

of decisions are involved in determining which and how inner mechanical and computational logics should be made apparent or accessible to users. Indeed, designers begin to account not only for the states and reasoning of an object but also of use. As Krippendorff reflects, "Indications of an object's states and logic need to afford users' conceptions, however different these conceptions may be from those of their inventors. In the extreme, the difference between engineering and scientific models (forms) and user's models (for constructing meanings) may be reflected in the difference between how the inside and outside appear respectively." [7]

It is the user interface that has become the site of mediation between the complex operations 'inside' and the context of use 'outside' a technological object. At a very basic level, computational complexity simply does not correspond to our everyday use. In using things such as photocopiers, we may be able to open (some) doors to fix paper jams – however, much of how the machine works cannot be reduced to questions of physical accessibility or mechanics but to electronics and computation. Indeed, even instructions for fixing paper jams may be given as instructions via a graphical interface on an LCD screen. In considering the spatial form of such objects, technological reasoning, character, and emotional persuasion – to recall Buchanan's argument – become issues of representation rather than of direct expression. What the system is literally doing, as opposed to what we might be able to do with it, become two very different things.

Use in time

The design of technological objects invites us not just into action, but into what we have commonly come to call 'interaction'. Spatial form, in making certain design intentions and technological reasoning perceptible, provides a basis for deliberation and action in use. Objects, thus, can be seen as the site where designers' and users' intentions meet. As a sort of medium through which a designer and user communicate, the form of objects invites us to become consumers and makes available operational possibilities that may be played out in use. However, the form of technological objects is not 'at hand' in the same ways as other things.

Certainly we might act in relation to technological objects as we might do other things. We might even sit on a photocopier as we might a chair – however, the ends to which such an object might be used alter considerably as we turn it on and acts upon mechanical and computational interfaces to print. As we make one selection via a button or drop-down menu, others become available that may then be acted upon, and so on. It is not enough to act 'once and for all' with respect to such objects – use involves ongoing commitment and continual choices, a give-and-take between actions and reactions. In fact, much, or even most, of the functionality of such objects is only available through rather extensive processes of interaction.

The form of technological objects, thus, unfolds over time. As discussed in 'Materials', such objects are characterized by computational processes that require us to think not just in terms of how they are configured in space but in terms of their temporal form. With respect to use, Lucy Suchman articulates a further temporal consideration: "The technical definition of 'interactive computing'… is simply that real-time control over the computing process is placed in the hands of the user, through immediate processing and through the availability of interrupt facilities whereby the user can override and modify the operations in process." [8] While certain aspects of spatial form may be apparent from the start, others may become available only through choices and actions of users. Control over whether or how the temporal form of such objects – how its spatial form might unfold over time – is up to use.

Typology

Within architectural discourse, the notion of 'typology' posits a basic set of forms that have persisted over time to become types. The historical notion was revived among neo-rationalists in the 1960s, with a larger impact once the original French texts and those of Italian proponents such as Aldo Rossi were translated and widely distributed. Rather than exact proportions or program, 'type' refers to a general essence of spatial form or organization. Rossi notes: "Roman monuments, Renaissance palaces, castles, Gothic cathedrals, constitute architecture. They are part of its construction. As such they shall always return, not only and not so much as history and memory, but as elements of planning." [28] Each type is itself essential and irreducible, the 'basic elements' of architecture. Types are 'found' through retrospection and analysis, qualified by their 'suprahistorical' endurance through historical fluctuations and sustained local relevance. As Rossi puts it, "I would define the concept of type as something that is permanent and complex, a logical principle that is prior to form and that constitutes it." [29] Typology signifies an attempt at establishing a foundation for analyzing and creating enduring architectural forms.

Any classification of typology must be open-ended. Types are continually being found – there can never be a closed set since present history continues to evolve. Types defy one-to-one relations between form and functions or users, as Rossi says "it is evident that every object has a function to which it must respond, but the object does not end at that point because functions vary over time." [30] Thus, type is neither merely an analytic tool nor a set of formal prescriptions, but a rather abstract principle of ideals, which may be analyzed and applied systematically. Quatremère de Quincy's 18th-century definition is often evoked: "The word 'type' represents not so much the image of a thing to be copied or perfectly imitated as the idea of an element that must itself serve as a rule for the model... The model, understood in terms of the practical execution of art, is an object that must be repeated such as it is; type, on the contrary, is an object according to which one can conceive works that do not resemble one another at all. Everything is precise and given in the model; everything is more or less vague in the type. Thus we see that the imitation of types involves nothing that feelings or spirit cannot recognize." [31]

Following such 'more or less vague' principles, typological approaches to design involve a complex relation of ideals, pragmatism, and judgment. In application, types perpetuate history and enduring ideals, yet may also allow for the individual choices and personal ideology of the architect. Rossi's Modena cemetery, for example, overlays elements of tomb, house, city, and cemetery types into a dynamic and unique combination. His architecture does not distinguish between nor merely copy modern and non-modern forms, but combines typological elements in inventive and highly personal ways with respect to the context at hand. "Type is thus a constant and manifests itself with a character of necessity; but even though it is predetermined, it reacts dialectically with technique, function and style, as well as with both the collective character and the individual moment of the architectural artifact." [32] While historically qualified and found by analysis, types must also be relevant within the contingencies of physical site and cultural contexts. Rather than mere application, typology requires ongoing transformation in design and in use.

Bigness

Reflecting decades later on the innocent reading of 'Learning from Las Vegas', Rem Koolhaas notes that any diversity of typology and particularity of vernacular has since been engulfed by 'programmatic lava'. [33] For example, he points out the 'Typical Plan' endemic – perhaps vernacular – to American commerce. As a completely generic form of architecture, it consumes vast (sub)urban territory without any formal relation

to program, event, or function. Such absence of content overwhelms and trivializes any contextual or critical design act – "This century has been a losing battle with the issue of quantity." From his perspective, the rational typological response based on tradition and convention is no longer relevant. "The infinitely reassuring dream of a world inhabited by a known series of typologies and morphologies, endowed with eternal life and capable of absorbing all programs, turns ominous when, for instance, Gunnar Asplund's Stockholm Public Library is shamelessly recycled in Luxembourg as the new European Parliament." In such cases – the program for the parliament included a 5,000 square meter conference center for which there is no typology – "Such unforeseeable programmatic explosions prove that typologies can no longer be stable; the program destroys the typology." [34]

Koolhaas' ongoing 'inventory of the present', based on studies of Manhattan and, more recently, cities in China and Africa, discounts theories that cannot withstand the scale of contemporary life. He relates architecture to urbanism, where staging uncertainty must replace stable and ordered configurations. In his firm's entry to the Parc de la Villette competition, which Bernard Tschumi eventually won, the Office for Metropolitan Architecture (OMA) state: "We have read the program as suggestions, a provisional enumeration of desirable ingredients. It is not definitive: it is safe to predict that during the life of the park, the program will undergo constant change and adjustment. The more the park works, the more it will be in a perpetual state of revision. Its 'design' should therefore be the proposal of a method that combines architectural specificity with programmatic indeterminacy." [35] Architectural solutions premised on flexibility in use and immense programmatic turnover must operate in relation to 'Bigness' both in space and time, building in indeterminacy and 'half-lives'.

Use
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In 1989, OMA was selected as the master planner for Eurolille. The town of Lille, due to increased integration of the European community, became a new transportation hub between France, Belgium, and the UK. The design brief was to insert an entirely new city – a program of 1 million square meters – directly into the heart of the ancient city. In certain respects, 'quantity' not only a constraint but a theme – "Cheapness is ideological in this situation because the virtual community can work only if the new Lille remains cheaper than the surrounding city... we had to construct, with each franc, a maximum quantity of new urban substance." Their 'users' were not only those within the local context, but trans-national masses flowing through, as well as the politicians behind one of the biggest projects in Europe. Their strategy included exposing logistical and political complexity – "OMA's only architectural intervention in the central sector was not an addition but a subtraction: at the point of greatest infrastructural density, an absence of building reveals the highway, railway, three levels of parking, and the metro... reverse process of creation we could simply eliminate a part - create a void, a hole - where we could reveal all the surrounding forces." [36] Such issues were articulated through formal debates as well, constructing a "dynamique d'enfer," or dynamic from hell, in planning meetings and in the press.

Cultures of use

Such vernacular notions exemplify various scales of use, from popular phenomena to suprahistoricity to sheer Bigness. 'Learning from Las Vegas' celebrated the real-time status quo in all the inconsistency, taste, ephemerality, and contingency of pop culture. It emphasized the contemporary rather than the historical, the exception rather than the archetype – as Venturi says, "it was not the prototype but the phenomenon at its most pure, rising from the open desert without historic underlays." Generated by a critical mass of people over time – "People 'voted with their feet' by going to Las Vegas" [37] – it was use amplified to the scale of cultural phenomena. Locality, for instance in the particular set of laws and zoning codes in Nevada, facilitated particular

kinds of development, perpetuated as widespread conventions through choice and action. However, the forms raised to the status of icons in the pages of 'Learning from Las Vegas' proved to be rather temporary in their material longevity and cultural relevance. As noted by the authors themselves a quarter of a century later and by Koolhaas, the Las Vegas they documented was quickly overrun, outmoded and replaced, the original examples becoming relics of a 'classic' era.

Such 'signographic', 'iconographic', and related semiotic notions in architecture have tended to emphasize specific and explicit relations between form and cultural communication, condemning the whole of a building to contingency on the present. The construction technique of the 'balloon-frame' is vernacular – even endemic – to post-war American real-estate development, including that of Las Vegas. Kenneth Frampton notes that the technique tends to "eliminate both structure and volume as intrinsic forms of architectural expression. Under these conditions, the architect's task is reduced to the provision of a marketable image, once an optimal rental return has been assured by the general arrangement of the plan." [38] Thus, the local and cultural relevance of the 'decorated shed' is based on a dangerous co-dependency between the built volume and communicative function of the facade. Over time, iconography may dissipate into caricature or relegation to past history. Forms based on separation of structure and image or form and content are perhaps more vulnerable to mismatches over time, due to asynchronous changes to one or the other.

Use
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Typological approaches explicitly aim at ahistorical and even apolitical principles. Past and existing forms qualify as elemental types because they persist 'without evolution' across space and time. Type refers to a spatial configuration that repeats itself in the city across time and functional change. Vincent Scully points out traces of Rossi's native Northern Italian heritage in his use of abstracted crossed mullion windows. However, he also points to Venturi's use of the same, drawn from other sources. Thus, whether in Venice or Nantucket, "Each has been able to see, perceive, and remember the vernacular forms of his own culture and hence to break out of modern 'design' to something deceptively more simple, even abstract, but in fact more traditional, basic and enduring." [39] Types are constituted both on basis of local relevance as well as persistence and repetition across space and time – they may be simultaneously particular and vernacular as well as permanent and universal.

Types are thus sustained through reoccurring use, which renews their relevance in everyday life and collective memory. Rossi compares urban life to theater, and its typical elements to those of a stage set that endures through individual encounters and cultural memory. Accordingly, he notes, "certainly the time of the theatre does not coincide with time measured by clocks, nor are emotions bound to chronological time; they are repeated on stage every evening with impressive punctuality." [40] Rather than linear, historical time, architecture and use are mutually reinforced through cycles of repeat performances. In stating that "in order to explain an urban artifact, one is forced to look beyond it to the present-day actions that modify it," [41] he indicates that the relevance of form is established by a critical mass of users and uses over time, persistence in habit and memory. A collection of more or less typical forms and multiple temporalities, the city is thus made up of elements in various and interdependent stages of evolution, renovation, growth, and decay.

These two notions illustrate different spatial and temporal scales for relating to form and use. The scale of analysis in the first case is limited to the forms in a particular context and era as the embodiment of cumulative practices of use. The more universal relevance of these are determined in the act of analysis, which presents a fixed set of historicized examples and suggested design principles, regardless of whether

the actual artifacts or the uses originally observed continue to endure. The 'more or less vague principle' of type indicates forms that are persistent in local cultures of use and in collective memory, though not overly determined by specific functions or individual actions. Since changing conventions and cultures of use entail that forms may emerge or retreat in relevance, the set of types must therefore be open and evolving, albeit over extensive periods of time.

Face-lifts and half-lives

Colin Rowe has pointed out an inverse relation between order and change, suggesting that in architecture a high valuation of one entails a low valuation of the other. [42] In the case of perpetual redefinition of a situation, he points out, no theory of fixed formal principles or other static order can survive. Each of these notions of vernacular represent different strategies for relating form, use, and context that entail different valuations of order and change.

As cultural meanings and use changed rapidly, vernacular forms in Las Vegas were relegated to a classic era or overtaken by a general 'programmatic lava'. In principle, separation of structure from facade in the 'decorated shed' should facilitate renewal through the possibility for constant 'face-lifts' – in reality, demolition is usually cheaper. Rossi's alternative perspective is that if form was merely a matter of expressing present-day actions and meanings, monuments would be hard to explain. If artifacts could continually reform themselves with respect to new functions, then the value of any given object would be constant and continuously available. Instead, he observes turnovers in function, indeterminacy in meaning, artifacts and regions in various states of decline, transition, and persistence. While instances of type may be elemental and fixed, their relevance fluxuates and the overall set of types evolves accordingly. In each of these notions, use is the changing factor – in the first case, change in culture outpaces that of form, in the second case, collective and cultural scales of use approach a more evolutionary rate of change.

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The slowness to the evolution of the set of types may, however, appear to approach stasis, particularly as other determining forces change rapidly. The notion of 'Bigness' reveals certain problems with formal paradigms that are overly mired in localities or history. Koolhaas notes a sheer volume and quantity of use that exceed any attempt through design at local containment or even expression of the phenomena through traditional means. Use is increasingly determined by global forces rather than local cultures or traditions, as illustrated by the shift of Lille from a peripheral region to a European hub. Reversion to past types, such as that in the parliament building, simply signals a failure in typological evolution to keep up with the order of magnitude of contemporary changes. The scale of use, rather than the particular qualities of form or persistence, massively exceeds corresponding change in conventional vernaculars or typological evolution. [43]

This implies a slackening of the dependency among form, context, and use. Form as an expression of program or function (as in the modernist 'duck') and as cultural iconography (as in the 'decorated shed') both seem to lose relevance. In Koolhaas' words, both might be viewed as formalist (dis)simulation – "The distance between core and envelope increases to the point where the facade can no longer reveal what happens inside. The humanist expectation of 'honesty' is doomed: interior and exterior architecture become separate projects, one dealing with the instability of programmatic and iconographic needs, the other - agent of disinformation - offering the city the apparent stability of an object." [43] Programmatic and cultural complexity, in his view, are perhaps better approached by building in 'half-lives', staging uncertainty, and exposing the forces at play. Koolhaas' conception of form relies not

Speculations
How might the sense of a technological object open up over long processes of use?

How might cultural conventions and existing patterns of interaction be extended or transferred to the design of technological objects?

How might relations to familiar things change with (invisibly) increasing complexity?

How might such things be formed by cultures and practices of use rather than – only – by design?

Hubub TV

Hubub TV investigated new services for interactive television, based on advanced technology and research into personalization in progress at Philips Research Lab.

In collaboration with internal stakeholders, concepts were generated and developed for gaming, commercial, and messaging services.

Mixing real-time information about local events and TV programs with accumulated information on individual habits and preferences, a system was proposed that would evolve in relation to personal and community choices over time. 3 levels of engagement were designed, based on content types, modes of interaction, and extent of immersion.

The final outcome was represented as an interactive walkthrough that was taken on for further concept and design development.

Scope
3 months, 1999

Institution
Philips Design, Philips Research Lab, Redhill UK

Project team
John Jansen
Jack Mama
Ramia Mazé
Paul Rankin
Liesbeth Scholten

Proposal
Extending an established product relationship beyond the 'dumb box' of the TV set, newly interactive services through Hubub are based on familiar content genres and mutual learning. Neither 'pushing' services onto users, nor relying on users 'pulling' from a vast array of options, the system unfolds in use.

Users would learn about the system even as the system would learn about them. Rather than implicit assumptions or tedious setup procedures, the personalization process is based on a combination of explicit dialog, patterns of action, and history of use. The system continually exposes choices, logics, and histories, opening up multiple levels of content and interaction within the system over time.

Unfolding in use, 3 levels of progressive engagement range from 'lean-back' to 'lean-forward' modes.

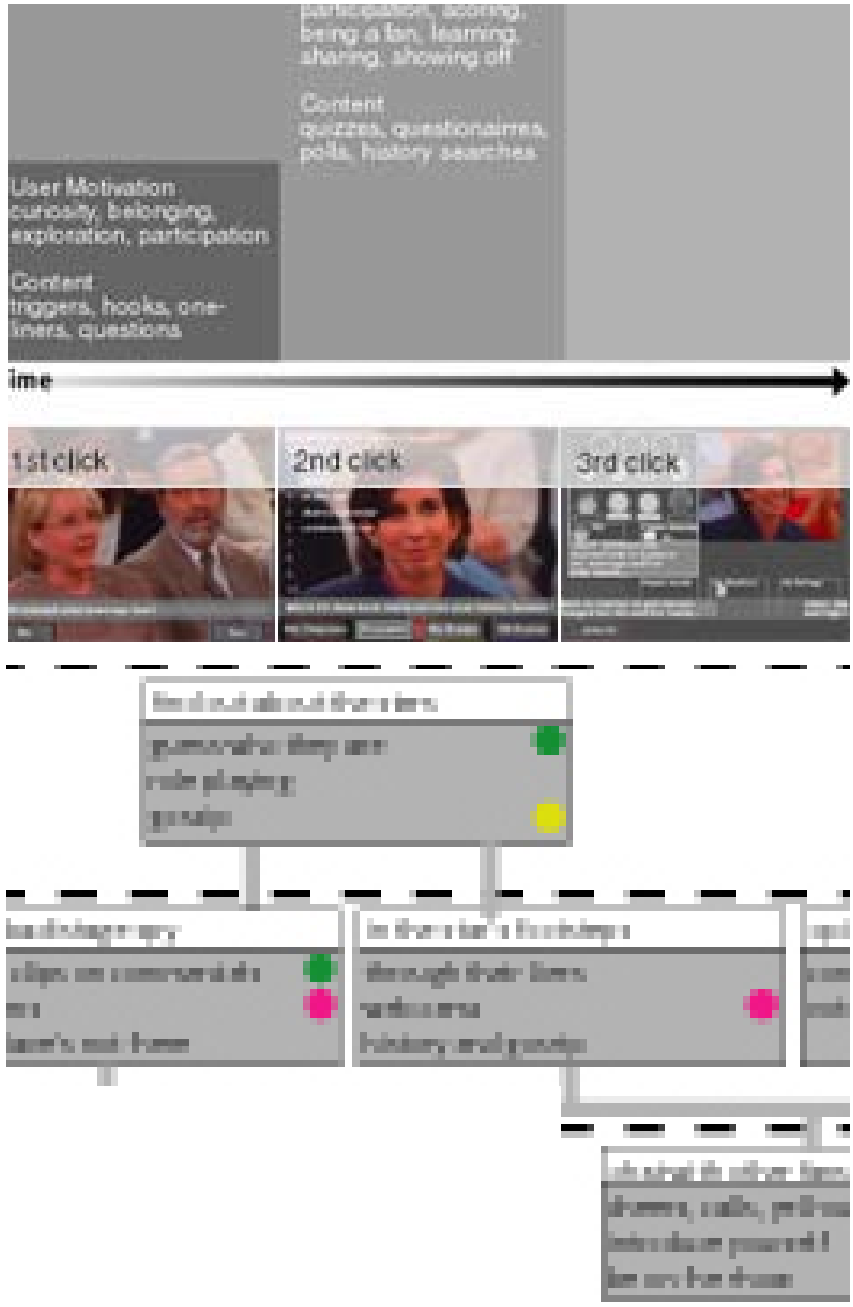
• Peripheral interface, premised on 'teaser' content and opportunistic interaction

• Targeted services, added value to TV use as custom content and reward schemes

• Immersive interface, services embedded in live social games and ongoing communities of interest

Interaction using a standard remote control is mapped to simple onscreen modules, growing in complexity with use over time.

In the long term, also taking into account product upgrades, patterns of individual, household, and community interaction would adapt the system. Under- or overuse, loyalty and critical mass would affect content types and presentation, as well as modalities of interaction, with future re-design to reflect evolving cultures of use.



on stabilizing context, use, and form, nor on principles of fixed relations between them, but on the notion of continual change internal to and among each of these.

Intervening in continuity

In application, the inevitability of future change reveals another set of issues – not only how to understand practices and histories of use but how to relate to this in design. Collective scales of use, historical scales of time, and unpredictability in the rate or nature of change contribute to the potential enormity of the situation in which a designer must nonetheless establish a basis for intervention. Koolhaas articulates the dilemma: "A contradiction lies at the heart of contextualist design: in the contextualists' favorite examples, these collisions and aborted utopias are literally generated by the course of events over long periods of time; but the modern contextualist is forced to telescope vicissitudes of centuries into a single moment of conception. In an act of more-or-less inspired projection, the contextualist generates a scenario that simulates the history of the next 400 to 500 years. Through this extrapolation in the name of history, the contextualist short-circuits historical continuity." [44] Irrespective of methods of analyzing the past or the present, even of the validity of views upon the future, the act of design inevitably and presumptuously intervenes, introducing new affects and effects.

How such concerns are approached and taken into practice reveals another set of methodological issues. The discussion around typological notions – particularly as it coincided with the emergence of the design methods movement – became a scene for debating approaches. According to various proponents, typology was alternately viewed as a vestige of craft tradition and a prescriptive formalist system. In the first case, aspects of intuition, tacit methods, and specialized knowledge were discussed as aspects of typological practice based on past solutions to related problems. Accordingly, Maldonado treated typology as an inevitable but provisional solution – "where it was not possible to classify every observable activity in an architectural programme, it might be necessary to use a typology of architectural forms in order to arrive at a solution. But… these forms were like a cancer in the body of the solution, and that as our techniques of classification become more systematic it should be possible to eliminate them altogether." [45]

Alan Colquhoun discusses the implications of such 'so-called scientific methods of analysis and classification'. He points out an underlying bio-technical determinism in such notions, itself a relic of modernist functionalism. Extending such logics, form would become the result of an objective, rational process in which operational needs and techniques were both fully known and completely matched. At the extreme, as Colquhoun points out, the implication is "architectural form as something which was achieved without the conscious interference of the designer." He argues instead that "the designer is always faced with making voluntary decisions, and that the configurations which he arrives at must be the result of an intention, and not merely the result of a deterministic process." [46] These examples, even as they are consciously situated historically and locally, reveal distinct choices in method of design and analysis, and the necessity of negotiating conventions in relation to the complex temporal and spatial reality of a given context.

Such negotiation is revealed to be both ideological and critical, situated and embodied, played out in written and practical forms of discourse, personal and disciplinary discourse. Conventions and principles have an important role in situating analysis of a complex design situation, but they are only a part – for Rossi, typology is the 'analytic moment' of architecture. While to some extent proven and given in advance, type does not determine but participates in a negotiation among various factors in a

situation, with technique, function, and style, cultural conventions and unique contingencies. The idea of type requires transformation, both as applied in particular design situations and as a basis for sustaining relevance with respect to changes in use over time. Design and use, thus, both unfold in relation to certain existing conventions and conditions – but rather than rote repetition, each involves processes of interpretation, negotiation, and transformation of what is known, given, or experienced.

Question of how analytic and formal concerns are situated within a design process, in relation to one another, and in the context at hand are uncertain. Colquhoun argues that, "to be meaningful, architecture must recombine elements already invested with conventional meanings, yet that same recombinatory act can itself be neither normative nor neutral; it is a value judgment of the individual designer with tractable ideological effects." [47] The basis for designing must be relevant beyond the design act itself, relating to scales of analysis and convention as well as to spatial and temporal scales of the context and use. The designer must establish such a basis for intervening in principle, in reality, and in person. Perhaps each design situation and intervention can be seen as inherently provisional, with ongoing negotiation in design and use as inevitable and desirable.

Use

Becoming users

Vernacular architecture

Use as participation

This discussion of vernacular in architecture reveals design as an intervention into ongoing cultures of use. Different ideas about use are exposed – whether acquiescence to the 'will of the people' and market forces, cultural resistance and historical continuity, or indeterminacy and half-lives. Approaches to order and change in use are thus reflected in relations between the 'insides' and 'outsides' of architectural objects, with respect to how meaning might be inscribed, imposed, or evolved. Use recognized as a powerful and determining force suggests the impossibility of design to merely perpetuate the existing or control the future. Design matters, but so does use, which tells in time. Such ideas start to erode any utopian and positivist claims for architecture as the basis for ordering and prescribing society – as Vidler articulated with respect to typology, it was no longer accepted that 'architecture write history'. [48]

'Objects' or 'things', at least traditionally, have been conceived as passive, inert, and static. However, accounts of architecture in use begin to reveal things as fundamentally open to change, even as they influence culture and order action. Alternatives to previously categorical distinctions between objects and subjects or body and mind, such as posed by phenomenological thinking, have only begun to permeate the relatively new fields of HCI and interaction design. Perspectives on design influenced by phenomenology and sociology have been important in revealing the life of things beyond the original design act and the role of users in interpreting, determining, and sustaining objects. Such perspectives take the world as a place of action, raising implications for how we might consider the construction of meaning through ongoing and practical encounters – forms of interaction created and sustained both through practices of design and of use.

There are, however, more ways in which we should extend such thinking to reconsider objects in design discourse. Accounts informed by existentialism and phenomenology can tend to reify subjectivity and experience, with things considered only as they are encountered. In architecture, for example, a focus on material objects in embodied experience and place-making can tend to be at the expense of recognizing the profound ways in which objects can change us – and the ways in which they are designed to do so. [49] A notion of vernacular, and the discourse around related concepts, complicate simplistic notions of determinism, either by design or by use.

As objects become increasingly complex and intelligent, we need to develop ways of reflecting on how to design relations between their insides and outsides as well as how such relations order and change use by design. Perhaps we must expand on existing – and seek further – perspectives for thinking about the 'life' of things.

In the making

The phrase "in the making" has become rather current in design discourse with a renewed interest in the philosophical tradition of pragmatism. [50] Within such a tradition, William James argued for a shift to thinking of things as always already in the making – as opposed to 'dead' things available for infinite decomposition by science, "vainly patching together fragments of its dead results." [51] Such a theoretical move presents new perspectives within a reconsideration of form. While drawing on pragmatism, Elizabeth Grosz has also looked to a range of other philosophical accounts to develop ideas about the spatial and temporal construction of relations among people and things. [52] For example, contrary to typical ways of treating the man-made, she points to Charles Darwin's account of the slow adjustment of living activities to varying conditions, in which objects are situated in time as an open-ended, even random, process of evolution. In this and other perspectives, things are not merely

conceived as inert matter against which we measure our own activity. Instead, each thing might be understood to have a 'life' of its own, evolving even as taken up into encounters with people and things.

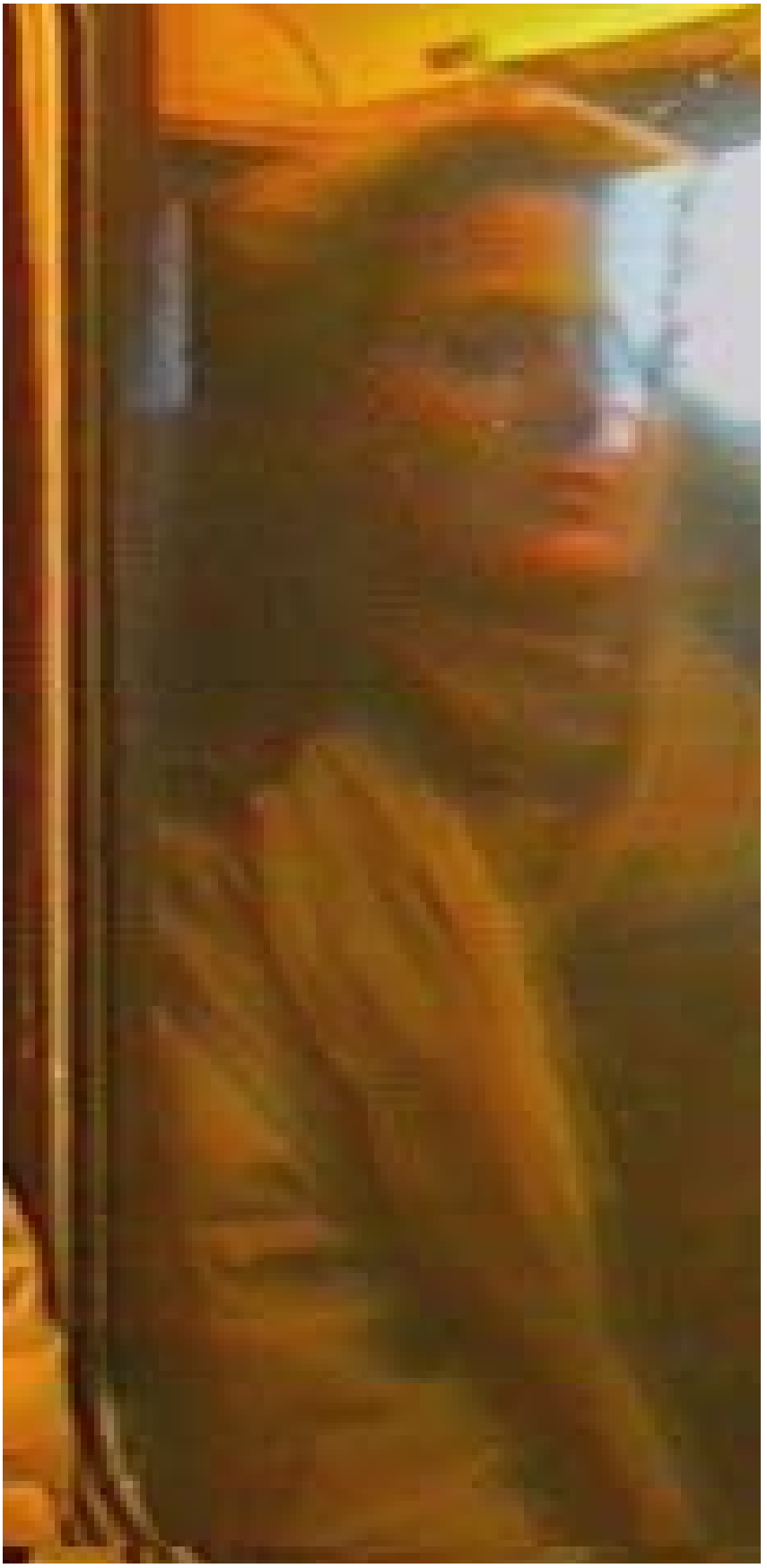
Things have their own temporal conditions, evolving or becoming something else over time because of their material performance and because they are taken up into our own intentions and actions. To the extent that everything has its own duration, or time in which it unfolds, the world becomes an intertwining of people and things not just as they come together in encounters in space but also in various temporal intersections. Grosz draws on Henri Bergson's philosophy to elaborate an idea that "each movement has its own duration, each event its own unfolding. These durations, though, are never simply isolated or self-contained but always both intersect with other durations (the durations of my actions may interact with the durations of the objects and materials with which I work) and participate in a kind of megaduration, a world duration that renders them in a web or weave of comparable and interlocked durations and becomings." [53]

In such encounters, chance comes into play as the openness of things to becoming, for better or for worse. Grosz comments on the notion of 'chance' in Darwin and Bergson: "Chance here cannot be regarded as indetermination, as the absence of a cause (as it is represented in classical philosophy); rather it is the excess, superfluity, of causes, the profusion of causes, which no longer produces singular or even complex effects but generates events, which have a temporal continuity quite separate from that of their 'causes'." [54] Simply because there are so many things and encounters as potentially determining forces, chance and open-ends are inevitable. Rather than as something that analysis or design should attempt to capture or fix, objects in use may be conceived as continually becoming something different than they may have been designed or even imagined to be.

Use
Becoming users
Use as participation

In such an account, objects are not opposed to subjects – rather people and things are linked together, determining a new set of possibilities by their interaction. "The 'object' is an exclamation point of joint experience," as Brian Massumi puts it, "It is an event: a rolling of subjective and objective components into a mutual participation co-defining the same dynamic." [55] People and things are engaged in a continual dynamic of encounters, each uniquely situated in space and time, thus each redefining meanings, intentions, and choices. Everyday life, thus, might be seen as an ongoing process of encountering and reconfiguring a set of possibilities in relation to our actions and things at hand. However, just as we might take up and change objects, it is objects which situate and provoke new action. Quite literally, it is objects that extend us beyond ourselves and into action in the world.

Things are not only the results of actions in design, 'final solutions' or objective ends, rather they provoke us to new actions. As Grosz puts it, "The thing, matter already configured, generates invention, the assessment of means and ends, and thus enables practice. The thing poses questions to us, questions about our needs and desires, questions above all of action: the thing is our provocation to action and is itself the result of our action." [56] The importance of design is not in the attempt to 'write history', to represent ideas and persuade us into action, or even to disappear as use might take over. Instead, design might reflect these as attempts to order the world, positing objects for us to reflect upon and react to. Such a role for design would create openings for increased reflection and participation, in design and in use.



Speculations:
How is technology already, perhaps invisibly, present in everyday life and sub-conscious interactions?

As it is exposed, might such technology be material for aesthetic experiences or popular imagination?

Rather than only intervening with more new technology, might recycling, redesign, and de-engineering be alternative strategies?

Nomadic Audio

Train, tube, street – in-between places and down time. As a service and interaction concept, *Nomadic Audio* propose an ambient audio experience available through ordinary mobile phones. The project explored the escape, daydreaming, and ritual of the everyday commute.

An audio stream would be generated from picking up and remixing existing local radio transmissions. Interference, speed, encryption, and congestion – normally engineered out of mobile phones – would instead be the basis for mixing and sound effects. Thus, a unique sonic experience is generated directly from the characteristics of passing through a particular sub/urban landscape.

The outcome was produced as a video installation and prototype of a re-designed phone headset for tuning in and out of various effects.

Scope
3 weeks, 1999

Institution
Computer Related Design, Royal College of Art

Project team
Ramia Mazé

Tutorial support
Anthony Dunne
Michael Fields

Process
The project was prompted by observations of long daily commutes. Results from distributed audio diaries revealed personal values of 'down time', familiar strangers, and daydreaming.

The visual landscape provides rich materials that people already use to create their own fantasies about connections between people, places, and things. The project evolved to provide an audio version.

Proposal
Nomadic Audio proposes 'de-engineering' mobile phones to expose the distortions caused by mobility. Off-the-shelf RF technology would then be added, as commonly used by 'plane spotters' and artists.

Scanning the RF (radio frequency) spectrum reveals a landscape of localized communication not ordinarily perceptible. Emissions from baby-monitors, cordless phones, and taxis leak through spatial boundaries. In passing, buildings, tunnels, and trees interfere with scanning; the friction of speed is apparent as the Doppler effect; emissions themselves are short range and typically encrypted.

The resulting sound is strangely familiar, a result of complex intersections among natural, built, and mobile environments. While a train's path is fixed, speed determines the overall sequence and effects.

A simulation of the sonic experience as prepared audio samples was distributed back to commuters to reflect upon during their commute.

A control mechanism was prototyped as a re-design of the mobile headset cord. Exploring different interaction metaphors in relation to the commuter studies, inexplicit 'fiddling', or tangibly twisting the cord was implemented in a working prototype for shifting between different RF ranges and sonic effects.

Interaction and change

If we understand the world to be made up as an interweaving of diverse temporal dynamics, our focus may easily shift to encounters rather than things. The design of experiences, services, and even processes come into focus. Certainly, perspectives such as those developed in experience design, service design, and strategic design are critical to understanding the interconnectedness of things in our lifeworlds and the role of design in sustaining the meaning of things in complex cultural and global systems. However, as technologies pervade and effectively disappear into the spaces and objects surrounding us, it can be easy to forget the profound changes to such things and how such things determine our own ways of being in the world.

With ubiquitous computing and the idea of the 'disappearing computer', for example, technology becomes invisible. As Mark Weiser articulates, "In other words, rather than being a tool through which we work, and thus disappearing from our awareness, the computer too often remains the focus of attention." Attempts to completely naturalize computation into things and behaviors in the real world can be seen in 'implicit input' rather than explicit interaction or 'seamless integration' of the physical and the virtual, where everything might be sensitive, intelligent, and reactive to our needs. Arguing that 'The World is not a Desktop', Weiser argues that the problem is not with metaphors and models in themselves, but rather that they are visible at all. He asks, "Why should a computer be anything like a human being?... Are human interactions so free of trouble, misunderstanding, and ambiguity that they represent a desirable computer interface goal?" [57] In his view, computers might become more intelligent and even better at communicating than us but, more to the point, they effectively disappear.

In taking such scenarios to the extreme, any interface between the 'insides' and 'outsides' of things effectively disappears – to our perception, to our awareness, and even to our memory. Weiser refers to Michael Polanyi, arguing for computers that disappear into the 'tacit dimension', ideally only ever 'ready-to-hand'. [58] As computers are reduced to tools 'through' which we act, we might cease to perceive and question the computation going on ever more pervasively around us. This raises new questions with both practical and theoretical implications, some of which will be further developed in the following sections on 'Participatory Practice' and 'Change'.

For one thing, disappearing computers and interfaces further obscures the inner workings of things from our perception and action. While ubiquitous computing and ambient intelligence might automatically sense everything from our movement to our moods, increasingly complex models about use and users built into technology may be even less available for us to perceive and change. Secondly, it may be difficult to tell which things are 'technological' or not. Certainly the 'artificial' is increasingly and often invisibly pervading everything from our bodies to our crops – accompanied by a debate that seems to be lacking with respect to the artificially intelligent things embedded in everyday life. Thirdly, complete integration and seamlessness might deprive us of the 'breakdowns' that – by revealing objects to our bodies and our awareness – expose the role that such things play in our domain of action and choice.

The history of technological objects is one of both diversifying and accommodating our activities. From kitchen appliances to photocopiers, technology facilitates an entirely new spectrum of activities we might engage with everyday. However, choosing to consume, use, and interact with such things changes us. As chairs have transformed the act and culture of sitting, we even forget that using chairs is a choice. We have expectations of 'good' or 'typical' chairs that design might serve – or expose and challenge. As acts involved in cooking and copying are increasingly replaced by

buttons and interfaces, interaction with technological objects becomes just as much a part of our bodies and cultural norms, our ways of thinking and perceiving the world. Just as we learn to speak the language that surrounds us, Tim Dant argues, we grow up learning patterns of material interaction appropriate to our culture.

As we try to learn from the domain of human and social interaction – whether in order to better design for interaction with technological objects or to improve upon them in ubiquitous computing – we cannot forget the importance of 'trouble, misunderstanding, and ambiguity'. As aspects of ordinary conversation in everyday life, these intervene in vocabulary and language, creating openings that require us to reflect, negotiate, and participate with others in constructing meaning. A variety approaches in HCI and interaction design have been exploring related perspectives. For example, creative 'breakdowns' are a means for reflection upon alternatives in participatory design, aesthetic approaches challenge the primacy of functionalism, and there are calls for design based on 'estrangement', 'seamfulness', and 'ambiguity'. [59]

To the extent that our increasingly artificial world is intentionally designed, social, cultural, and political ideologies are embedded in things and in our patterns of interaction with and through things. Dant argues, "What the changes in material culture have produced is a society that we confront not so much directly through our interactions with its members or leaders but through our interaction with the material world that surrounds us." [60] Designing the spatial and temporal forms of interaction with technological objects, we must reflect upon how we – as designers and users – merely affirm or may create openings for participation, change, and critique.

Notes

1 Silverstone and Hirsch, *Consuming Technologies*, 19.

2 Morello, "(Re-) Discovering Users and Projects," in *Discovering Design*, ed. Buchanan and Margolin, 69-70.

3 Tisseron, *Comment l'Esprit Vient aux Objects* (Paris: Aubier, 1999), quoted and trans. Dant, *Materiality and Society*, 108.

4 Gilles, quoted in *Origin of Things*, ed. te Duits, 22.

5 Buchanan, "Declaration by Design: Rhetoric, Argument," in *Design Discourse*, ed. Margolin, 103.

6 Krippendorff, "On the Essential Contexts of Artifacts," in *Idea of Design*, ed. Margolin and Buchanan, 167.

7 Krippendorff, "Essential," 167.

8 Suchman, *Plans and Situated Actions*, 10-11.

9 Suchman, *Plans*, 11.

10 Winograd and Flores, *Understanding Computers and Cognition*, 78.

11 Suchman, *Plans*, 88.

12 Suchman, quoted in Laurel, *Computers as Theater*, 78.

13 Schlegoff, quoted in Suchman, *Plans*, 95.

14 See Laurel, *Computers*.

15 A seminal view of speech act theory in computer science is Winograd and Flores, *Understanding.* For an overview of speech act theory in IT see Ljungberg and Holm, "Speech Acts on Trial," in *Computers and Design in Context*, ed. Kyng and Mathiassen.

16 See Dourish, *Where the Action Is*.

17 Winograd and Flores, *Understanding* , 166.

18 Abowd, Mynatt, and Rodden, "The Human Experience," *Pervasive Computing*, 54. See also Dourish, "What We Talk About," *Personal and Ubiquitous Computing*.

19 Dourish, *Where*, 4.

20 Dourish, "What," 22.

21 Dourish, *Where*, 101.

22 Akrich, "The De-Scription of Technolgoical Objects," in *Shaping Technology/ Building Society*, ed. Bijker and Law, 206.

23 See Rudofsky, *Architecture without Architects*; Boudon, *Lived-in Architecture*; Brand, *How Buildings Learn*; Alexander, *Pattern Language.*
For a brief view on vernacular in (post)modern and current design see Betsky, "The Strangeness of the Familiar in Design," in *Strangely Familiar*, ed. Blauvelt.

24 See Colquhoun, "From Bricolage to Myth," *Oppositions*; Gandelsonas, "Neo-Functionalism," *Oppositions*; McLeod, "Architecture and Politics" (*Assemblage*, 1989), reprinted in *Architecture/Theory/since 1968*, ed. Hays.

25 Venturi, Scott Brown, and Izenour, *Learning from Las Vegas*, 64.

26 See Colquhoun, "Sign and Substance," *Oppositions*.

27 Maldonado, *Design, Nature and Revolution*, 60. For the architects' response see Scott Brown, "On Architectural Formalism," *Oppositions*. For a discussion of the general debate, see McLeod, "Politics".

28 Rossi, quoted in Scolari, "The New Architecture," in *Architecture/Theory/since 1968*, ed. Hays, 133.

29 Rossi, *Architecture of the City*, 40.

30 Rossi, *Scientific Autobiography*, 74.

31 de Quincy, *Encyclopedie Méthodique d'Architecture 1* (Paris, 1788), quoted in Rossi, *City*, 40. See also Vidler, "Type: Quatremère de Quincy," *Oppositions*.

32 Rossi, *City*, 41.

33 See Koolhaas, "Junk Space," *Domus*.

Use
Becoming users
Notes

Use
Becoming users
Notes

34 Koolhaas and Mau, *S,M,L,XL*, 961, 285.
35 Koolhaas and Mau, *S,M,L,XL*, 921.
36 Koolhaas and Mau, *S,M,L,XL*, 1198, 1200.
37 Venturi and Scott Brown, "Las Vegas after its Classic Age," in *Iconography and Electronics*, 123, 125.
38 Frampton, "Place-Form and Cultural Identity," in *Design after Modernism*, ed. Thackara, 54.
39 Scully, "Postscript: Ideology in Form," in Rossi, *Scientific*, 116.
40 Rossi, *Scientific*, 29.
41 Rossi, *City*, 59.
42 See Rowe, Introduction to Eisenman et al., *Five Architects*.
43 Koolhaas and Mau, *S,M,L,XL*, 500.
44 Koolhaas and Mau, *S,M,L,XL*, 283.
45 Maldonado, quoted in Colquhoun, "Typology and Design Method," *Arena*, 11.
46 Colquhoun, "Typology," 12.
47 Colquhoun, "Historicism and the Limits of Semiology," reprinted in Colquhoun, *Essays in Architectural Criticism*, 25.
48 See Vidler, "The Third Typology," *Oppositions*.
49 For related arguments see Dovey, *Framing Places*; Dovey, "Place / Power," *Architectural Design*; Moore, "Technology, Place, and the Nonmodern Thesis," *Journal of Architectural Education*; McLeod, "Politics".
50 For example, as the subject of two recent unrelated conferences: Ockman, ed. *Pragmatist Imagination*; Binder, Gall Krogh, Redström, and Mazé, eds., In *the Making: Proceedings of NORDES*.
51 James, "Things in the Making," in *Pragmatist*, ed. Ockman, 27.
52 See Grosz, "Notes on the Thing," in *Pragmatist*, ed. Ockman.
53 Grosz, *Architecture from the Outside*, 124.
54 Grosz, "Becoming... an Introduction," in *Becomings*, ed. Grosz, 4.
55 Massumi, "Toward a Pragmatics of the Useless," in *Pragmatist*, ed. Ockman, 161.
56 Grosz, *Outside*, 169.
57 Weiser, "The World is not a Desktop," *interactions*, 8.
58 See Weiser, "The Computer for the 21st Century," *Scientific American*. See also, Polanyi, *Tacit Dimension*.
59 See, for example: Bødker, *Through the Interface*; Chalmers and Galani, "Seamful Interweaving," *Proceedings of DIS*; Dunne, *Hertzian Tales: Electronic Products;* Ehn, *Work-Oriented Design*; Gaver, Beaver, and Benford, "Ambiguity as a Resource for Design," *Proceedings of CHI*; Graves Petersen, Sejer Iversen, Gall Krogh, and Ludvigsen, "Aesthetic Interaction," *Proceedings of DIS*; Hallnäs and Redström, "From Use to Presence," *ACM Transactions*; Redström, "Aesthetic Concerns," in *Pervasive Information Systems*, ed. Kourouthanassis and Giaglis.
60 Dant, *Materiality*, 147.

Participatory practice

The preceding section on 'Becoming users' explored relations between design and use in the form of objects. As we choose to become consumers and then make ongoing choices to take up design objects to achieve various purposes in use, things become incorporated into our everyday lives. It is the spatial form of objects that makes design intentions and possibilities for use available to perception and action. However, not all possibilities may be completely available – indeed, we might have to move around an object or move the object itself to discover what it is like and how it works. More specifically, the form of technological objects requires use to unfold. It is as a user acts upon a thing – for example, acting on a choice presented by the physical or digital interface of a technological object – that further options become visually or otherwise available, which may then be reacted to and acted upon in turn. The form of technological objects, thus, unfolds through interaction.

Interaction interweaves computational processes with processes of use. Each act of use is itself unique to particular situations and circumstances. As in ordinary human interaction, certain aspects are given in advance – however, choices in use are determined locally, contingent upon personally embodied actions and socially negotiated meanings. While technological objects are to some extent constructed in advance by design, they are also determined in use, as people encounter, incorporate, and reinterpret courses of action available through them. Not unlike architectural objects, we might consider the use and even the form of such objects to have a 'life' long after design. Indeed, 'vernacular' architecture is determined more by time than by design – inextricable from cultural processes, shaped by convention, adapted through history, and sustained by ongoing use. Design, in such terms, is an active and ideological intervention into contexts and continuity, whether by validating conventions, setting new ones, or opening possibilities for local and ongoing change.

Use
Participatory practice

Use of objects, particularly of technological ones, denotes a participative status. Objects in use are appropriated and adapted into personal lifeworlds and everyday practices. Technological objects require interaction in order to unfold – use plays a determining role in which possibilities are engaged. Interaction involves not just an all-purpose choice to consume or ongoing commitment to use – it involves particular and explicit choices over whether and how the form of the object unfolds over time. Certainly, choices involved in interaction may become cultural norms or like second nature to us, such as sitting in chairs, tracing habitual paths through a familiar building, or automatically punching in selections on a photocopier. However, just as the choice to buy something commits us as consumers, and embodied action commits us to interpreting things in use, interaction commits us to participating in behaviors determined, at least in part, by the design of technological objects.

Thus summing up previous section suggests some implications for reconsidering 'Use'. Familiar objects, from TVs to homes, increasingly interconnect and communicate. The logic of such technological objects involves complex technical reasoning and design judgments beyond sensory perception and ordinary comprehension in everyday life. Nevertheless, use involves continual interpretation, action, and even 'giving form' to such things – perhaps without our even being aware of it, as in 'context awareness' and 'implicit interaction' in ubiquitous computing. Such interactions are deeply embedded into the space and time of everyday life, committing us to patterns of behavior designed by others. We may easily forget that our actions are choices and that interaction is participation. Thus, it is even more important to recognize the choices involved in use and our role as participants in forming everyday life and material reality.

This section on 'Participatory practice' looks explicitly at notions of participation and implications for interaction design. There is an established discourse on such notions in Participatory Design, which is important to relate to, as well as to challenge and expand in relation to the particular concerns raised here. Looking at 'participation in architecture' and 'tactical media', other contrasting approaches to agency, choice, and change in use might be traced and juxtaposed. Through such perspectives, this section examines a range of examples and practical approaches to reconsidering participation in the processes and products of design.

These issues drawn from the previous section on 'Becoming users' synthesize some points for further discussion in the section on 'Participatory practice' to follow here:

Objects
While typically objects may be perceived as static or inert, we might understand technological objects to unfold through the form of interaction with them in use. In practice, this implies that we consider how objects may invite interaction and thus participation in formation.

Openings
Always already in the making, technological objects must be considered as 'open' not only in terms of spatial but temporal form. Interaction design, in particular, must consider participation in processes and products that may have a 'life' long after design.

Intervention
To the extent that the form of interaction is up to both design and use, conventional notions of 'process' and 'product', 'designers' and 'users'. In practice, this entails renewed consideration of respective roles and responsibilities.

Practices of use

The issue of participation has a history in design that is ideological as well as operational. An oft-quoted reference is Sherry Arnstein's 'ladder of civic participation' that sets out a hierarchy ranging from 'manipulation' to 'citizen control', emphasizing power relations. James Wilsdon and Rebecca Willis set out another argument for public participation in scientific and technology development. They identify three basic reasons for engagement: normative, instrumental, and substantive. The normative view posits that participatory processes should take place because it's the right thing to do, perhaps it is even the sign of a healthy democracy. The instrumental view holds that participation helps increase public trust and investment in various possible (though perhaps predetermined) outcomes. The substantive view aims to engage people actively and before decisions are taken, such that they may be more socially robust and culturally sustainable. Laying out some basic motivations for participation, these perspectives also involve views on social and ideological engagement. [1]

Questions of user participation in design may too easily be reduced to dialectics like inclusive/exclusive, global/local, democratic/authoritarian, bottom-up/top-down, totalitarian/pragmatic. [2] Considering objects in terms of spatial and temporal form, and forms of interaction, brings use and users even further into the realm of design. At the same time, technologies and technical skills, as well as information and expertise about design, are increasingly widespread and accessible, blurring conventional boundaries between designers and users. As design and technology paradigms evolve, it becomes increasingly important to revisit and challenge what 'participation' might mean. As technological systems proliferate and extend into all aspects of daily life, new discussions must be generated as to their social construction.

To redress 'participatory practice', conventional notions of 'users', of 'participation', and, ultimately, of the processes and products of 'design' must be reconsidered. These are traced here through various theoretical perspectives, existing approaches in design, and related examples. As a general background, user-centered perspectives have contributed to our understanding of and methods for involving people into design – however, there are certain unknowns with respect to use. Particularly with respect to new technologies and the emergence of entirely unprecedented applications and forms, use is inherently uncertain and users unpredictable. Rather than taken at face value and passively consumed, things are engaged in 'discovery in use' – besides altering their form, ongoing discovery may involve fundamentally altering intended functions. Outside or on the fringes of product development, hobbyist and activist movements exemplify such an expanded notion of use.

To ground notions of participation in relation to established perspectives in design, diverse practices are examined. The field of Participatory Design, for example, has long developed theoretical and methodological frames for involving people into systems development. In many countries, architecture may be legally bound to institute stakeholder participation or public consultation in decision-making, raising questions about the codes and conventions delimiting expertise. Further, hactivist and tactical media practices develop alternatives with respect to public rights and means for participating in closed processes and proprietary products. Certainly, these areas of practice are distinct in historical, ideological, and methodological terms. Thus, it cannot be possible here to do justice to the particulars of each – rather, the intention here is to draw out certain aspects to problematize what have become perhaps conventional assumptions, and possible opportunities, for further developing notions and approaches to participation in interaction design.

In place of conventional dialectics and in light of changing socio-technical conditions, there is a need to revisit the distinction between 'those who design' and 'those who use'. In line with the discussion in the section on 'Becoming users' of objects as temporal and becoming, always 'in the making', participation involves ongoing 'construction work', and an interplay of participating people, situations, and things.

End 'users'

Even as design and use 'meet' in a technological object, as use unfolds spatial and temporal form in sequences of interaction, there are nonetheless asymmetries between the act of design and that of use. As Bruno Latour points out, there is temporal asymmetry between 'absent makers' and 'occasional users'. Things are created prior to use, in order that they might become available to be used at all – that they have been created does not, however, ensure that they will in fact be used or how they will be used. There is also information asymmetry. Sonali Shah argues that two sets of information necessary for product development – information on users and information about solutions – are held disproportionately between developers and users. No matter how solidly rooted in prediction or persuasion, design may not meet the circumstances of use precisely, as each may be based on different intentions and information. Temporal and information asymmetries are basic conditions in design. [3]

Such problems have been central to design methods and user-centered design. As John Chris Jones has articulated: "The fundamental problem is that designers are obliged to use current information to predict a future state that will not come about unless their predictions are correct. The final outcome of designing has to be assumed before the means of achieving it can be explored: the designers have to work backwards in time from an assumed effect upon the world to the beginning of a chain of events that will bring the effects about." [4] The design methods movement started in the UK in the 1960s to address such conditions involved in the activity of designing. Its proponents, of which Jones was one, were concerned that designers' knowledge and skills become more explicit and externalized, particularly as product development become more complex, large-scale, and collaborative.

To this end, proponents engaged in systematic study, articulation, and development of design methods, drawing particularly on systems design and engineering fields. While traditional methods might make local improvements and changes, the new methods were directed at the total situation, with rationality viewed as a way of extending beyond individual expertise. Though design methods flourished for a time, the movement eventually failed, in part due to reconsideration by its own proponents. In application, rationality was often seen as a replacement for experience and intuition, reducing design to mechanical application of a toolkit of rigid methods. As Jones notes, "There was a phase in the sixties when many architects had a mania for design methods, but it wasn't everyone that had the mania. I think it was only the rational part of design methods which became popular, and it only became popular with the kind of person who is very keen on rationality." [5] While related perspectives continue to resonate, a range of reactions, such as in Participatory Design, emphasize instead the social, cultural, and situated aspects of design and of use.

User-centered design draws on diverse means of studying, analyzing and incorporating user needs and values into product development. In addition to design methods, user-centered approaches also draw on ethnography and anthropology, cognitive and behavioral science, marketing and management studies. The ideas and methodologies drawn from such areas are intended to improve and apply information about users into design, whether prior to design development (as in ethnographic studies, market surveys, or focus groups), in cycles of iterative design (as in 'contextual',

'collaborative', or 'co-'design), or afterwards (as in usability testing). The results of various methods might be brought into design as reports, user profiles, or guidelines. Personas, cultural probes, and experience prototypes are also means of synthesizing and representing ideas about use and users. Participatory design, discussed further below, engages users and stakeholders directly into design processes. [6]

While greatly expanding knowledge and information in product development, such methods can never completely alleviate asymmetry. Design methods and user-centered design increase understanding and empathy with users in product development. Inevitably, however, design activity is future projection based on 'prediction', to borrow Jones' term, however well grounded in studies of past history, present conditions, or future trends. Just as such temporal asymmetry remains, despite increased information in design processes, uncertainty as to eventual use can never be fully resolved – not to mention production, packaging, distribution, marketing and other processes of 'purveyance' intervening between design and use. [7] So, while increased information and knowledge is undoubtedly valuable in development processes, increasing the amount or quality of information may not in be the only way to consider users, or relations between 'those who design' and 'those who use'.

Use
Participatory practice
Practices of use

With respect to relations between design and use, we might consider assumptions embedded in the term 'user'. While product development may include a range of different types of designers, engineers, and other contributors, 'user' tends to be applied to anyone outside the proximate activity of development – to generically denote the vast majority of people who will encounter and engage with products. It seems to suggest that there might exist a typical user or range of users, and that, in any case, people may be considered only in reference to products. In HCI, Jonathan Grudin points out, "The term 'user' retains and reinforces an engineering perspective… These terms simply assume that everything is in reference to a computer. This systematically distorts our perception of the user-computer partnership." [8] Reducing users in the design process to information and representations, or treating them merely in relation to an activity or a product already in place, posits people in terms more similar to that of objects to be studied rather than as active participants.

This problem of 'users' is not merely one of methodology or terminology. Certainly, general use of umbrella terms may unnecessarily obscure complexity and uncertainty inherent in design activity. More significant, however, is the embeddedness of such notions in the history of industrial production and the rise of corporate and engineering culture. In such traditions, products and services are developed and protected by a manufacturer, circumscribed by proprietary techniques and closed design processes, with external inputs only incorporated in controlled and legally-proscribed terms. As Eric Von Hippel notes, "a user's only role is to have needs, which manufacturers then identify and fill by designing and producing new products." [9] Reducing people to users reinforces the idea that it is companies that are the primary agents controlling change and progress. The role of design is reduced to problem-solving, just as use is reduced to passive consumption – both design and use are 'downstream' of technologies already in place and future directions already determined. Uncritical approaches to 'users' inherit – and thus may perpetuate – such traditional notions.

There are good reasons for challenging such conventions. First, generic notions of use and users do not necessarily coincide with a post-industrial society in which much innovation and product development takes place outside industry. Secondly, proprietary products and closed processes may limit or close down possibilities for people to discover and engage meaningfully with products. Third, such fixed notions of use may not accommodate our understanding of the use of technological objects as

committed participation, as an ongoing achievement, and as sort of 'formgiving' in itself. While it may be impossible to avoid using term 'user', this section questions and expands perspectives on people as participants in design and development.

Tendencies in post-industrial technology and society challenge passive conceptions of users. Von Hippel notes that increasingly accessible resources are leveling differences between designers or developers and users. Open and affordable technology and communication platforms are expanding access outside industry to individuals and communities. Users' ability to adapt or make things for themselves is "*radically* and *rapidly*" changing, even supplanting product development in certain domains. Additional challenges to conventions of 'production' and 'profession' are posed by a 'Pro-Am revolution', Charles Leadbeater and Paul Miller argue. [10] Pro-Am characterizes the established and growing participation of committed amateurs in various fields ranging from music to science. Rather than simply users, such amateurs might range from proto-, pre-, or semi-professionals, to former or post-professionals, organized in communities and working in relation to professional standards.

A variety of examples illustrate that users and amateurs have been and are increasingly playing a large role in product development. Major 'first-of-type' innovations in sports have been made by users – skateboarding, snowboarding, and windsurfing developed as existing products broke or were adapted by adventurous users. Innovations developed by 'open source' knowledge communities can be traced from the 18th-century iron industry to the contemporary computer industry. The personal computer emerged from activities of the hobbyist Homebrew Computer Club and hacker subculture has been central to the development of the Internet itself, the World Wide Web, and the Linux operating system. Astronomy is a field where Pro-Am and professional practice have grown together to the extent that they have become completely interdependent. While there may be limits and asymmetries ("Amateurs do not produce new theories of astrophysics" [11]), such examples enrich a notion of users as participants and contributors to knowledge and product development.

With respect to how people engage meaningfully with products, this also challenges mainstream product development consideration of people only as consumers and potential end- or target-users. Examples of 'non-work' activities do not conform to conventional notions of 'labor' or 'consumption'. Certainly, as Von Hippel outlines, hybrid business models are emerging, such as 'lead-user-led' projects. However, most people engage in non-work activities for reasons of satisfaction, personal growth, leisure, cultural, and community welfare. Such activities escape terms of primary market exchange – the types and products of activities may often be 'payment-in-kind', philanthropic, and hobby or arts-and-crafts production. Just as such people do not (and may not want to) participate in such activities as 'work', neither do they conform to the methods typically used to study or evaluate consumption.

Exceeding conventional categories of work, this also relates to an expanded range of values that motivate participation. Alexander Galloway argues that early computer networks embodied the hacker values of engineers, academics, and hobbyists who devised, deliberated, and eventually agreed upon them. Decentralization, openness, transparency, consensus, flexibility, accessibility, anticommercialism, and anti-authoritarianism were designed into the architecture of the Internet. [12] The 'open source movement' has ideas and terms of engagement far beyond mere software development. Embodying a particular attitude to the rights and use of information, the movement is rooted in use. David Garcia states: "The digital revolution thoroughly upset prevailing Western ideas about intellectual property. Thanks to the Internet there is an extensive network in which ideas are not so much protected by copy-

right as developed collectively. Ownership is not what counts, but use." [13] Explicitly operating outside the proprietary terms and closed processes of traditional product development, 'use' is a basis for participation and effecting change.

With respect to use, this further shifts focus from objects as static or fully given in advance, to things that are continually becoming and 'in the making'. Many inventions are discovered in use – for example, skateboards developed in the 1940s as the handle accidentally broke off (often homemade) wooden scooters. Von Hippel points out that one consequence of information asymmetry is that users tend to develop things that are functionally novel, based on highly particular situations, whereas industrial innovation tends to improve upon well-known needs based on rich knowledge about solutions. While product development may focus on past, intended, or predicted use, use in context and in communities generates other innovations. Shah argues, "Users generate and accumulate information based on product use in extreme or novel contexts, the creation of new (unintended) uses for the product or service, and accidental discovery – in addition to intended product use." [14] In this sense, use is a productive activity – though not in a conventional sense of 'work' – and, quite literally, as an ongoing personal, social, and cultural achievement.

Use
Participatory practice
Practices of use

While artifacts are the material link between design and use, reducing processes respective to each activity to a static conception of form focuses attention on the wrong things. Such preoccupation might end in trying to design for users in terms of what might be analyzed and fixed, instead of recognizing and allowing for inherent uncertainty and complexity in use. Johan Redström suggests, "As the possibilities for alternative interpretations are systematically reduced as a result of the designer's attempt to optimize the design with respect to fit, the room for finding our own solutions, possibly coming up with interpretations that are more interesting than the original intent, is reduced to a minimum… We'll be surrounded by objects that try to fit us very closely and as a result, most of the space for improvisation and interpretation will be occupied." [15] Designing to 'fit' use confines the operation of designers and users to a narrow and perhaps overly object-oriented spectrum of relations. Instead, perhaps we need to think of artifacts as opening up and leaving space for people's activities and achievements, the more complex relations among people and their actively constructed and ongoing social and material realities.

These perspectives suggest that we need to reconsider conventional notions of use and users. If we only try to better address temporal and information asymmetries, it is possible that our scope of imagination and operation may be reduced to what can be safely predicted and known. At one extreme, this could restrict 'design' to what might be preconceived in design processes and predetermined through design products. An implication might be that the meaningful and inventive purposes for things that might be found in use – unintended (or mis-)use – would be seen as a 'failure' of design. At the other extreme, everything might become design. All sorts of creative and inventive activities might be recognized, albeit with different sets of values, organization, remuneration, and accountability. If such extremes are mutually exclusive, this separates 'those who design' from 'those who use' unnecessarily, even as it leaves both downstream of larger technological and societal changes.

These extremes may not be too far from reality, but they also leave a vast space in between – perhaps it is in this space that more complex varieties of collaboration, co-determination, and participation might fall. Thus, having set various problematics with respect to 'end-users' – or even the end of 'users' – the following discussion shifts more explicitly to explore participation in practice.

Participation in design

In their views on public engagement and participation, Wilsdon and Willis make the case that risk is socially constructed. They argue that new technologies involve unknown environmental and social consequences, entailing risk both in venturing into new possibilities and in responsibility to effects incurred. If such risk is socially constructed, not only the venture but the responsibility may be considered both part of design but also of committed use. The future – rather than something that may be safely predicted and fixed – is collaboratively constructed and determined by the ways in which all of us encounter and engage with development processes and products. Therefore, it is not only important to take risks but to open these processes and products up to participation, both in operational and ideological terms.

Some approaches

To ground perspectives and issues, consider some approaches to participation in various design-related fields. Participatory Design, for example, develops a range of methods for approaching the design of technical systems and objects in terms of social and democratic values. Such participation must vary in relation to different fields of practice, as architecture exemplifies. In architecture and technology, activist perspectives challenge and thus contribute to our notion of participatory practice. Below, respective examples are presented as a basis for further discussion.

Use
Participatory practice
Participation in design

Participatory Design

Participatory Design (PD), sometimes referred to as cooperative design, is a field concerned with incorporating end-users as full participants in development processes. Originating in the 1970s as part of the Scandinavian workplace democracy movement, early projects were developed with trade unions to incorporate technology in ways that enhanced rather than replaced workers' skills and local knowledge. As it spread outside Scandinavia and to other domains of practice, explicitly political agendas diffused into more general motivations of emancipation and empowerment. As a collection of methods, techniques, and concerns, PD has become a central perspective in user-centered design. At the Participatory Design Conference in 1994, Tom Erickson set out four dimensions along which user participation in development might be measured: directness of interaction with the designers; length of involvement in the design process; scope of participation in the overall system being designed, and; degree of control over the design decisions. [16]

While many project examples are oriented around workplace contexts and concerns, a range of methods have been developed and widely applied, for example in civic, educational, and mobile applications. The early and seminal 'UTOPIA' project was developed with the Nordic union for graphic workers, employing 'design-by-doing' methods such as workstation mock-ups and organizational games in participatory workshops. The recent 'COMIT' project combined ethnographic and participatory methods to develop application concepts for mobile devices. Rapid studies of three small business owners or mobile workers were conducted using video ethnography and cultural probes. Resulting materials were the basis for concepts created together with users and representatives from partner companies, developed in workshops by means of scenario creation, props, and enactment. The project drew on methods foundational to PD, such as 'design games', cardboard and foam mock-ups, and Forum theater techniques, as a basis for facilitating on-the-spot and collaborative concept development and representation. [17]

PD focuses on means for opening up design processes, representations, and products to participation by stakeholders with diverse skills and expertise. Mock-ups,

games, and enactment, for example, are simple means for anyone to represent and communicate ideas, regardless of design, technical, or even language skills. While much emphasis in PD has been on methods and process, there has also been interest in means for tailoring and reconfiguring systems in use. In 'Atelier', a European Union research project developing mixed-media environments for education, configurability was a principle both in the design process and in objects produced. [18] Prototypes acted as boundary objects in collaborative processes, as materials for field trials, and as final outcomes. The 'tangible archive', for example, consisted of various materials, such as modular furniture, materials samples, and digital files. These could be reorganized and configured both physically, by rearranging the spatial elements, or digitally, by means of RFID technology and video projection. Expanding earlier PD experiments with modularity and configurability, this project took 'construction work' as both characteristic of collaborative design work and of ongoing use.

Participation in architecture

In architectural practice, temporal and informational asymmetries are acute – roles, decisions, and responsibilities are regulated not just by convention but by legal and professional codes. Knowledge and skill are defined not only by education but by accreditation and contract, which delineate the role and responsibility of the architect in relation to that of other experts such as engineers and officials. As Jeremy Till puts it, "One of the defining features of any profession is that it has its own knowledge base, and the more specialist the knowledge base the 'stronger' – and more exclusive, better remunerated – the profession." [19] As part of the architectural profession, there are often legal requirements to carry out consultation with the public or localities. Since boundaries in architecture are more delineated with respect to roles, expertise, and accountability, questions of participation are approached differently than in other fields and are therefore interesting to relate to here.

As in other areas, participatory ideas in architecture gained currency in the 1970s. Typically, participation is discussed in the same terms as that in other fields – that is, direct user engagement in design processes and decisions – with examples in Ralph Erskine and Lucien Kroll. There are, however, other examples that engage dynamics specific to architectural practice. While not sharing the same social or political concerns of typically participatory architects, Cedric Price (associated with Non-Plan and Archigram, discussed elsewhere in this text) explicitly attempted to catalyze public action. His 'Inter-Action Centre' was built in 1971 to be changed over time, with prefab units that could be plugged in and out of a spaceframe infrastructure. [20] During the inevitably lengthy planning permissions process, it was designed to be 'under construction', to accommodate interim performances and circuses. Price insisted that a twenty-year lifespan be written into the contract, after which he assumed that entirely unpredicted uses of the site would – and should – take precedent. In the project, a range of official and informal uses, even unforeseen ones, were built into the construction and planning process as well as into the structure itself.

A range of contemporary experimental practices involve participation. 'Muf art + architecture' shift attention from the products of architecture to politically and socially situated processes. [21] Their 'Shared Ground', for example, involved collecting diverse local opinions and mapping the overlapping ownership of forecourts, roads, and sidewalks. Outcomes included a video documentary entitled '100 desires for Southwark Street' and a series of subtle interventions in surfaces along the street, such as public benches inserted into boundary walls, a wallpapered bus stop, and curbs redesigned to articulate public and private space. The 'atelier d'architecture autogérée' (aaa) draws theoretically on Deleuze and Guattari, pursuing strategies of desire rather than power and transversal rather than consensual or organized

participation. [22] Combining gardening, cooking, and meeting, their 'ECObox garden' is a network of self-managed locales that both occupy and preserve urban green spaces. 'Architect-activists' take on 'urban curating', operating between municipal and local interests to situate 'design actions'. These examples engage stakeholders directly or obliquely, through participatory processes or provocative actions.

Tactical media

A variety of (more or less) related approaches have developed for intervening into technological systems. Since the 1990s, 'hactivism' has been joining the concerns and methods of hacking and activism to engage issues of free speech, political expression, and information ethics. [23] Alternately seen as politically constructive 'electronic civil disobedience' or as cyberterrorism, actions have included parody websites, hacking into corporate systems (HBO's television satellite or Amazon.com's recommendation system, for example), and countersurveillance measures. 'Tactical media' often employs similar methods, aiming to reverse the one-way flow of information and power of mass media. Rather than large-scale strategies or actions, it is expressly 'tactical', acting opportunistically and over time, intervening into loopholes and vulnerabilities in systems. An example project is the 'StreetWriter' by the Institute for Applied Autonomy (IAA) that mounts industrial spray-paint technology on the underside of vans to print messages on street pavement that can be seen from far away. The smaller-scale 'GraffitiWriter' is based on remote-controlled toy cars repurposed for $500 using Do-It-Yourself (D.I.Y.) instructions.

Nathan Martin extends related principles into a notion of 'parasitic media'. [24] Such forms of technological intervention operate within large systems, contributing nothing to their survival but growing by various tactics, such as 'slicing' (for example, extracting small amounts of digital cash from banking systems), or leaching off a host system. The Critical Art Ensemble, for example, proposes the development of a color-igenic compound (dye) that would bond to agricultural chemicals manufactured by the Monstanto corporation – the result would be large-scale visibility of genetically-modified crops. 'Soft' parasitism might include 'sniffing' open wireless networks by moving through a geographic area – a practice called 'wardriving' – prompting 'war-chalking', or forms of marking such networks for others. Martin makes a distinction between parasitic and other forms of tactical media – where mainstream media and public disruption is the aim of the latter, parasitism relies on a secret and even symbiotic relation to systems.

To some extent, hactivism, tactical, and parasitic media have been appropriated into other areas, such as 'urban informatics' and 'locative media'. Geo-hackers, locative media artists, and psychogeographers are seen as key players in constructing the 'geospatial web' – the next generation of the Internet in which digital and geographical information are linked through telecommunications and GPS systems. The 'Urban Tapestries' project, for example, explored public authoring – participants used mobile devices to attach and retrieve stories, pictures, sounds, and videos in real locations around London. Related projects include 'Pirates!', 'Uncle Roy All Around You', and 'Fiasco'. Examples extending the social and ethical concerns of tactical media are IAA's 'iSee' that addresses surveillance and the 'Milk' project that exposes trans-national stakeholders in the food industry. Ben Russell expresses a central concept of locative media – "what was once the sole preserve of builders, architects and engineers falls into the hands of everyone: the ability to shape and organize the real world and the real space… Overlaying everything is a whole new invisible layer of annotation. Textual, visual and audible information is available as you get close, as context dictates, or when you ask." [25]

Issues of participation

These three notions expand and challenge notions of user participation in design. People are not considered merely as users, as passive objects of study or possessors of needs, addressed in design development through analysis, problem-solving, and well-fitting products. Rather, people are considered as stakeholders, active in developing products – whether directly involved in product development processes or in adapting products to use. However, there are distinctions in how PD, architecture, and hactivism treat participation. Architectural objects and open source software, for example, require different considerations and tactics. Where PD focuses developing openings in processes of design, hactivist and related practices do so in use. Each takes different perspectives on the role of processes and products as interventions into social systems and everyday life. To expand upon such notions of participation, we might take a further discussion of these in relation to the issues outlined at the start of this section, that is, 'objects', 'openings', and 'intervention'.

Objects

In these approaches, objects or artifacts are engaged various ways – in processes of design or of use – to open up for participation. In PD, the emphasis has typically been on the design process, with a range of organizational and creative techniques developed to engage stakeholders directly into decision-making and designing. Artifacts are often engaged within participatory workshops, design-by-doing, and collaborative learning, for the purposes of engaging a more inclusive discussion and for building consensus. For example, widely understood formats, such as theater and games, and mockups made of craft materials open the activity of designing to people with diverse skill-sets and roles. In the COMIT project, props resembled the 'cardboard computer' that operated in UTOPIA to encourage hands-on experience and collaborative experimentation. The role of the props surpassed that of grounding design work, becoming 'things-to-think-with', intrinsic to language and argumentation. In PD, making artifacts is not just a question of product development, but of constructing a framework for collaborative work.

Use
Participatory practice
Participation in design

Artifacts in participatory processes may extend beyond such processes, whether by intention or not. In muf's Shared Ground, the video of resident interviews operated as a form of internal research, as a form of advocacy within 'collaboration-consultation' processes, and, ultimately, as a product for consumption by the general public. In fact, the video connected a range of stakeholders – far beyond the official client, direct 'end-users', or those who might feasibly participate directly in a collaboration workshop. As both process and product, the video extended engagement outside the scope of the design activity and past the end of the project itself. Similarly, after the COMIT project ended, kits of process materials were taken by participants back into their companies, where they might continue to be used for representing or communicating ideas. Things produced in design processes, thus, may have effects beyond proximate stakeholders or the duration of the process itself.

Indeed, artifacts may be designed explicitly to engage uses unintended or unimaginable within a design process or project. The IAA merely describes ways for people to construct their own robots from off-the-shelf parts, it does not prescribe use. In the Atelier project, technological and architectural modules were constructed in advance, and were continually repurposed by various stakeholders. The components were open enough, whether in terms of multifunctionality or configurability, to be employed as process materials, in on-site trials with design students as end-users, or deployed by those very students in the city to involve involved another range of participants from among the public. Price's Inter-Action Center was comprised of generic and prefab units, with the idea that it would always be in some sort of con-

struction, reconfiguration, and deconstruction process. The scale of effort involved would entail considerable and ongoing community commitment to change, as well as making such commitment visible by means of its own state of (de-)construction.

Artifacts may be designed to be more or less open to participation, for example through the use of low-tech materials, modules, and open source or D.I.Y. techniques. In fact, hactivism illustrates the power of just such commitment – it is not the openness of artifacts but their very resistance that invites action. Investing with financial resources and time in a contestational robot or the Inter-Action Center requires considerable individual commitment and even community-building. Participation in constructing or changing these may be invited – through an obviously unfinished appearance or open source knowledge, organized game or workshop formats, or shared principles and ethics within a community. In such participatory approaches, thus, the 'community of practice' and associated values and artifacts are central. However, such a common basis may not necessarily hold in use across distributed or multiple communities, or over time.

Openings

One way of conceiving of objects as 'open' to participation is to think of them as easy or hard to access. Certainly, such a skill-based account is evident in attempts to make objects more accessible through low-tech or open source materials. Low-tech or low-fidelity prototypes used in the design process for COMIT shifted focus from the object as a potential product to, as Eva Brandt and Jörn Messeter put it, 'things to think with' and 'things to act with'. Cardboard, foam, and LEGOs are easily and quickly changed, such that anyone could express or change an idea by acting directly on artifacts. Similarly, the GraffittiWriter, the 'tangible archive', and the Inter-Action Center are all open systems intended to make it easier for people to participate. However, other artifacts, such as those targeted in tactical media, are quite hard to crack and yet nevertheless catalyze significant participation in the effort to do so.

Therefore, we might consider another way to think of 'hard' than in terms of skill – Usman Haque argues, "If softspace encourages people to become performers within their own environments, then hardspace provides a framework to animate these interactions." If 'hardspace' – whether conceived as architecture or hardware – might be seen as a framework or infrastructure, then the 'softspace' is what really matters. Thus, he proposes that "if an architect designs interaction systems then the production of architecture – which exists only at the moment of use – is placed in the hands of the end user… architects simply design the meta-systems." [26] In such an account, artifacts are conceived not in terms of whether they are easy/hard to use or change but in terms of the interactions generated, over time, in use.

In locative media, certain aspects must be selected or designed in advance – technology platform, database structure, and indexing mechanisms, for example, must be set up and maintained. However, the content of systems like Urban Tapestries is authored only by participants. In this system, people are not centrally monitored, they must chose to locate themselves. Content becomes available only as they travel through the city, since it is located spatially. 'Softspace' might be seen as the content, located in the 'hardspace' of the city and of the content management system – 'production' depends upon a critical mass of people choosing to participate through a large urban territory and to continue to do so over time.

Similarly self-perpetuating, the Fiasco game is a mobile urban competition, based on stunts proposed, performed, and judged by participants. It depends on social relations – challenges are often posed within and between social groups or 'posses'.

As one of its designers, Elizabeth Goodman, notes, "Hackability is contextual: it is not inherent in artifacts but rather arises from tensions between specific artifacts and specific groups of people. To effectively design for hackability, we must critically engage with the social pressures that drive people to do-it-themselves." [27] In this case, 'softspace' involves continual choices about whether and how the system might be made to participate in one's own lifestyle and social networks, both of which are ongoing regardless. Haque argues, "applying *open source* to architecture suggests a collaborative democratic project that exists in time as well as space: an architecture that is created by people through its use, as a performance, a conversation, a bodystorm that goes on throughout the life of the architectural system." [28]

Thus, participatory practice is not just a matter of relating to skill, but of relating to the wider context in which stakeholders decide whether to participate or even maintain systems at all. Indeed, some acquire high levels of expertise in order to repurpose systems for their own social and ideological purposes – 'slicing' cash and infiltrating crop seed are labor-intensive and high-risk interventions. A great deal of effort is made, though not to support or even destroy the 'host' system. Participation succeeds not by democracy but by Darwinism – a highly sophisticated parasite depends upon a highly successful host system, its joint product only appearing in time.

Intervention

Use
Participatory practice
Participation in design

In these examples, it becomes clear that setting the conditions for 'participation' is not only up to design – just as risk and artifacts are socially constructed, with political and ideological resonances, participatory practices must be as well. More accessible design tools and technologies certainly open up new possibilities. Objects may invite or even provoke action. However, in the end, there is a much wider spectrum of social and ideological factors that condition people's motivation. That the Inter-Action Center stood long after contractually agreed might be a result either of the building's surprising sustainability or simply of community neglect. Outside design processes and after design projects end, participation must be taken up and sustained in use.

Systems like Atelier, Urban Tapestries, and Fiasco explicitly refuse 'total design'. Components, infrastructures, and even persuasive 'hooks' are considered, such as play, curiosity, and competition. However, what happens within and to the system is ultimately left to use and users. For example, Fiasco only works on the basis of rewards – there are no standards for validation or quality control, or mechanisms to manage contacts or locations. It is not a matter of 'ease of use' but of seeing if, when things were left open, users would step in and take over – for the designers, it was "an experiment in loss of control." [29]

In the 1970s design discourse dominated by competing ideas of scientific rationality and social advocacy, Colin Rowe and Fred Koetter argued that "these alternatives – Let science build the town and Let people build the town – are both of them profoundly neurotic. For, up to a point, science will and should build the town and, up to a point, so will and should collective opinion; but the never ending insistence on the incompetence of the architect… should at least be recognized for the psychological manoeuvre that it is – as a guilt-ridden attempt to shift the locus of responsibility." [30] Questions of skill and roles often come to the fore in notions of participation. It does not necessarily follow that downplaying skill and leveling roles (even 'dumbing down' design for general consumption) necessarily entails better participation or results – as Gillian Rose put it "the architect is demoted; the people do not accede to power." [31]

However, perhaps because architects must take their profession seriously, roles are much in focus, sometimes in very constructive ways. As advocates or experts,

architects may insert opportunities for representing and debating alternatives within conventional systems. For example, muf reflects, "Inadvertently we had become the effective conduit of information between the council and a population hostile to change. Consultation can also be an exchange... Project by project we designed temporary accommodation for voices and knowledge which, like the design of the studio, were big enough for difference." [32] As architects, they took their public responsibility seriously enough to challenge their clients and the 'universal' value of the architect's role. They redefined their practice in terms to include social advocacy and public art, so that they could engage different roles and sets of skills to achieve different effects as needed.

Not unlike architects, hactivists have been known for holding themselves and others to high ethical standards. While informally organized and often known only by group names or pseudonyms, reputation is gained both through skilled achievement and a common code of ethics. Thus, social pressure can be a mechanism for regulating and enforcing responsibility for actions. A cross between architects and activists, the aaa call themselves 'architect-residents', 'architect-citizens', 'architect-users', living and working in the communities and the structures that they build. In these examples, participation, taken in a wider ideological sense, does not mean demoting experts or abdicating responsibility. It is not a simple matter of 'leave it to the experts' versus 'power to the people'. It is a question of how, when, and why power – and consequent risk and responsibility – is handed over or taken up.

Use

Participatory practice

Participation in design

Toward participatory practice

Tracing some concerns and examples of PD, participation in architecture, and tactical media reveals certain problems and possibilities with participatory practice. On one hand, participation based on consensus, collaboration, and community may not hold across different domains and cultures of practice. Certain shared ideas and methods may be negotiated within a well-bounded PD process – but, as Susanne Bødker notes, "the collective experiences of participation are often only for those directly involved in the project, and only while the process is running." [33] Expanding openings through design processes and in products may increase the range and diversity of participants and forms of participation. On the other hand, as distinctions between design and use blur – or are broken down through organized or activist means – issues of authorship and accountability become likewise diffused. Shifting away from a generic and passive notion of 'users' entails that everyone, as participants in shaping artifacts and systems in one way or another, has a stake in addressing critical issues. For interaction design and design practice in general, a notion of participatory practice requires renewing consideration of how and what we design.

When asked how his tactical media work differs from the "failed participatory models of the seventies," Andreas Broeckmann suggests a contemporary shift from 'the collective' to 'the connective'. He states, "It is characteristic of the forms of agency that evolved in networked environments that they are neither individualistic nor collective, but rather connective… Whereas the collective is ideally determined by an intentional and empathetic relation between actors, the connective is an assemblage that rests on any kind of machine relation and is therefore more versatile, more open, and based on the heterogeneity of its members." [34] Participation in such systems, thus, may not be characterized by consensus or even by collaboration. While certainly those who produce such systems may be thus characterized – as in Pro-Am, communities of practice, and the open source movement – the systems in and of themselves may not. While a common value system was transposed into the basic architecture of the Internet, the same cannot be said of other socio-technical infrastructures that constitute large technological systems.

Considering the design of technology as it moves outside of established and regulated contexts, such as PD processes and stable workplaces, additional issues are exposed. Thomas Binder, reflecting as the focus of his PD practice moved from industrial to mobile technologies, noted: "We believed (as most other systems designers) that we, through the process of participation, could manage to negotiate these new issues on the level of exposing and negotiating interest. What we did not see was that we had entered a new realm of form that we were incapable of addressing directly." [35] For example, mobile technologies operate in relation to large-scale infrastructure and associated devices that, while always interconnected, were used, located, and owned in different and conflicting ways. As in the COMIT project, distributed technologies lead to a disarticulation of the elements of computing, thus suggesting new questions as to what to design at all.

Just as it may no longer be clear what to design, how to design is also called into question. Certainly increased information and participation in design processes helps with temporal and informational asymmetries in product development. Indeed widening our understanding of people outside conventional notions of users is part of the intention here. However, merely improving design processes and products will not solve inherent uncertainties in design and may in fact obscure other problems. While certainly participation and collaboration in design are important, what happens in between and afterwards may not be available for us to know or to design

at all. Therefore, perhaps a more important implication of reconsidering participatory practice is to expose this uncertainty in the activity of designing and to approach design as a framework for opening up – rather than resolving or better-fitting – relations between design and use.

To open up such relations, it might be necessary to seek differences rather than consensus, to stage irresolution rather than solutions. Binder reflects, "we had taken to our heart the new self-image of the architect-designer, we had also fenced ourselves in a reservation for user consent that left us out of touch with the design of the larger technological structures." [36] Muf raises questions that might seem radical with respect to classic participatory ideals of consensus: "Although it sounds obvious to say it, a collaboration is about difference, otherwise why bother? Acknowledging difference... is the substance of collaboration, far more than the material outcome that may or may not result." In processes and products, muf suggests that design might construct – literally and metaphorically – "room for doubt." [37]

While we might – and should – develop approaches for inviting participation in processes and products, another approach might be to design for inherent uncertainty. This might be evident in examples explored in the sections 'Material life' and 'Becoming users', and in 'meta' design suggested by Haque and others. [38] However, the danger in developing new design strategies is in trying to contain the unknown and unpredictable, as in notions of 'total design' that will be discussed in the section on 'Design effects', or in disassociation from ideology and consequent responsibility, as seems to echo in some tendencies within locative media.

Even if design processes and products become more inclusive and participatory, use still involves interpretation, deliberation, and perhaps contestation. Observing ongoing disputes among end-users of systems that they had participated in developing, Binder notes that "negotiations were not once and for all." [39] Price's Inter-Action Center was never used as expected (and that was his intention), but neither was it demolished as contractually agreed. In Fiasco, it is precisely such 'cultural afterlife' that is targeted. Its designers argue that 'hackability' is contextual rather than inherent in artifacts, therefore the system relies upon tensions between artifacts and within groups of people. Such tension – 'the social pressures that drive people to do-it-themselves' – is suggested as a principle to generate and sustain the system in use. For the designers it was an experiment in under-designing and loss of control.

With respect to designing for appropriation, Wendy March, Margot Jacobs, and Tony Salvador ask: "Should we be trying explicitly to create open and adaptable systems, or is user adaptation an example of re-engineering and hacking that will take place regardless of our design intentions?" [40] Along the lines of Jonathan Hill's argument that architecture is made by use and by design, we might argue that the constructed environment is – already and inevitably – co-produced. [41] Artifacts, whether architectural or technological, are continually made, appropriated, patched, and redesigned. While certainly design processes and products can increase the possibilities for participation, difference and change are inevitable in use. Rather than only trying to build consensus or a better fit between design and use, the examples here reveal rather disparate ideas about participation itself – which might be another basis for sustaining communities of practice and commitment in use. Such tensions may be taken into design processes and projects, opening up a common 'room for doubt'.

March, Jacobs, and Salvador pose another related question: "Is everyone really a designer?" [42] Certainly, participatory notions break down distinctions between the roles of designers and users. For example, PD relies on accessible and shared

methods, reducing the boundaries to participation posed by differences in skill, expertise, and ownership. Pro-Ams and tactical media demonstrate an increasing variety of ways in which individuals and communities may engage in reconfiguring and inventing systems – trends that increase as technologies and technical skills become more commonplace. Practitioners are also explicitly repositioning their own roles – muf acts as advocates, aaa as residents and citizens, 'tactical media'-tors as facilitators. Open objects and ongoing 'construction work' explored in such approaches challenge traditional notions of and distinctions between design and use. In doing so, other issues are raised which we must also find ways of addressing.

Shifting towards a more participatory basis for design development also effects a shift in responsibility. Henry Sanoff suggests that whether participants' needs are actually met may matter less than the feeling of having influenced the decisions. This is characteristic of the 'token' or 'placatory' participation that can characterize the public forums required by law for deliberating architecture and planning. It may be a way of shifting responsibility for decisions and effects away from politicians, clients, or designers and onto those who must live in or with the design products in the long run. Thus, Till argues that it is ultimately irresponsible to demote or de-professionalize architecture. Participation may be employed for emancipatory ideals – indeed, it may support a more explicitly and openly social construction of risk. However, other dynamics of power might just as well be embedded in mechanisms and methods for, to borrow Arnstein's terms, 'manipulation' or 'citizen control'. Even if participation is engaged for the best of intentions, it may have side effects such as producing a market for the developed product or acting as a form of hidden persuasion. [43]

This implies the increasing importance of examining bases for inviting participation into processes and products. As participation might be said to more generally characterize the use of technological objects, ideological and methodological underpinnings of design cannot just be assumed, but must be exposed and negotiated. However, conventional mechanisms for positioning ideals and methods – such as discipline, profession, and authorship – may be less relevant, since categories and roles are increasingly blurred and shared. Other communities of practice suggest alternatives. As a relatively established and now rather substantial movement, the public nature of open source enables both continuity and self-regulation within the community. Formal and informal hacker cultures generally acknowledge a shared 'code of ethics', which has been successfully enforced on several occasions, within a loose community that relies on reputation as well as competition among peers. Hactivism, while blurring disparate practices of art, activism, and computer programming, maintains (more or less consistently) recognizable principles of autonomy and opposition.

Locative media, on the other hand, has been widely criticized for not interrogating its own embeddedness, and thus complicity, in larger economic and power relations. Broeckmann suggests that since locative media is fundamentally based on the appropriation of technologies of surveillance and control, its practitioners have a duty to address that fact in their work. [44] However, locative media practitioners often embrace the role of 'early adopters' or 'lead users' in developing applications, content, and even markets around technology systems.

As in locative media, the same questions might be posed in interaction design. Anne Galloway and Matthew Ward argue that as systems are combined together for new purposes, there may be a consequent loss of ground for criticality and accountability. This is a result of smoothing out relations of difference – production and consumption, public and private, authorship and ownership. [45] Similarly, Minna Tarkka raises the issue of "immaterial labor as servile labour, a work-without-end-product

where communication and cooperation are the main productive forces. This is exactly the situation in participatory media, where artists increasingly operate as service providers: their work becomes that of building platforms for user participation and collaboration, and of maintaining and moderating communicative situations." [46] Between the extremes of 'everyone is a designer' and the legal regulation of the architect's profession, there must be room for practices in which participation might become increasingly significant, without sacrificing expertise and accountability.

To revisit notions of participatory practice, this discussion exposes problematics of consensus, power, and accountability. The examples challenge simplistic dialectics of global/local, bottom-up/top-down, and totalitarian/tactical. Ideas, methods, and cultures of participation, in fact, increase the permeability of such opposites, opening a range of variables (and issues) between. A nihilistic and unconstructive conclusion to such blurring of boundaries and convergence of roles would be to conclude that 'everyone is a designer', 'everything is design' – and therefore 'nothing is design'. Such rhetoric from conceptual art may be provocative (Duchamp is often evoked in such discussions in media art and locative media), but it does not directly apply. Participation in interaction design involves a less-established disciplinary basis, different power relations among stakeholders, and more extensive and long-term dynamics of use. Reactions to 'every/no-thing is design' might range, on one hand, to a complete breakdown of distinctions (and thus loss of criticality and accountability) or a new fundamentalism (as in vehement defenses of architectural professionalism).

In order to explore and position alternatives, we must further develop notions of participation in practice. Haque's reaction to the conundrum 'every/no-thing is design' is to look not just at the theory or structures behind but at how participation plays out in reality. In theory, he argues, open source software systems are open to anyone, but in practice it has not meant that everyone has become a programmer. While some build new code, there are a range of other ways of participating that may be situated in relation to values and contributions of the general community of practice.

With respect to interaction design practice, the next section, 'Public Play Spaces', reflects upon a design program in which my colleagues and I have attempted to probe into and experiment with some notions of participation. Rather than solutions, we aimed to ask questions and challenge assumptions – echoing muf, "I think for us success can be measured in the confidence we have not to give a simple answer but to give space for that uncertainty." [47]

Notes

1 See Arnstein,"A Ladder of Citizen Participation," *Journal of American Institute of Planners*; Wilsdon and Willis, *See-Through Science*.

2 See Till, "Architecture of the Impure Community," in *Occupying Architecture*, ed. Hill; Till, "The Negotiation of Hope," in *Architecture and Participation*, ed. Blundell, Petrescu, and Till.

3 See Latour, *Pandora's Hope*; Shah, "Open Beyond Software," in *Open Source 2.0*, ed. Cooper, DiBona, and Stone.

4 Jones, *Design Methods*, 9-10.

5 Jones, *Designing Designing*, 39. See also Cross, ed. *Developments in Design Methodology*; Mitchell, *Redefining Designing*.

6 For a spectrum of methods in user-centered design see Aldersey-Williams, Bound, and Coleman, eds., *Methods Lab*; Blythe, Overbeeke, Monk, and Wright, eds., *Funology: From Usability to Enjoyment*; IDEO, *Method Cards*; Koskinen, Battarbee, and Mättelmäki, eds., *Empathic Design*; Laurel, ed., *Design Research*; Moggridge, "51 Ways of Learning about People," *Designing Interactions*.
For some specific approaches see Beyer and Holtzblatt, *Contextual Design*; Bueno and Rameckers, "Research for Innovation," *Proceedings of ESOMAR*; Nielsen, *Usability Engineering*; Cooper and Reimann, *About Face 2.0*; Salvador, Bell, and Anderson, "Design Ethnography," *Design Management Journal*; Buchenau and Suri, "Experience Prototyping," *Proceedings of DIS*.
For references on Participatory Design see below.

7 For example, see SERVO, "Purveyance Practice in Collaborative Design," in *ReShape!*, ed. Arrhenius.

8 Grudin, "Interface," *Proceedings of CSCW*, 270-1.

9 Von Hippel, *Democratizing Innovation*, xviii.

10 See Leadbeater and Miller, *Pro-Am Revolution*.

11 Leadbeater and Miller, *Pro-Am*, 15.

12 See Galloway, *Protocol: How Control Exists after Decentralization*; Longford, "Pedagogies of Digital Citizenship," *Techné*.

13 Garcia, quoted in Kaspori, "A Communism of Ideas," *Archis*, unpaginated.

14 Shah, "Open," 4.

15 Redström, "Towards User Design?" *Design Studies*, 15.

16 Erickson's comments in Kuhn and Winograd, "Participatory Design," in *Bringing Design to Software*, ed. Winograd.
For background on Participatory Design see: Bjerknes, Ehn, and Kyng, eds., *Computers and Democracy*; Bødker, Kensing, and Simonsen, *Participatory IT Design*; Greenbaum and Kyng, eds., *Design at Work*; Muller, Wildman, and White, "Taxonomy of PD Practices," *Communications of the ACM*; Schuler and Namioka, *Participatory Design*.

17 See, for example, Bødker, Ehn, Kammersgaard, Kyng, and Sundblad, "A UTOPIAN Experience," in *Computers and Democracy*, ed. Bjerknes et al; Ehn, "Cardboard Computers," in *Design at Work*, ed. Greenbaum and Kyng; Ehn, *Work-Oriented Design*; Brandt and Messeter, "Facilitating Collaboration," *Proceedings of PDC*; Messeter, Brandt, Halse, and Johansson, "Contextualizing Mobile IT," *Proceedings of DIS*.

18 See Balka, Wagner, and Jensen, "Reconfiguring Critical Computing," *Proceedings of Critical Computing*; Binder et al., "Supporting Configurability," *Personal Ubiquitous Computing*; Iacucci et al., "Configurability in and Integration with," *Proceedings of Mobile HCI*; Ehn et al., "Atelier" (report).

19 Till, "Negotiation," 31.

20 See Price, Obrist, and Keiller, *Re:CP*.

21 See muf, *This is What We Do*.

22 See Petrescu, "Losing Control, Keeping Desire," in *Architecture and Participation*, ed. Blundell Jones et al.

23 For an overview of history and examples see Jordan, *Activism!*; von Busch and Palmås, *Abstract Hacktivism*.

24 See Martin, "Parasitic Media" (online).

25 Russell, quoted in Tuters and Varnelis, "Beyond Locative Media," (*Leonardo*, 2006), online, unpaginated. See also: Lane and West, "Urban Tapestries," *Proboscis Diffusion*; Björk, Falk, Hansson, and Ljunstrand, "Pirates!" *Proceedings of INTERACT*; Benford et al., "Uncle Roy All Around You," *Proceedings of ACE*; Chang and Goodman, "Fiasco," *Proceedings of DIS*.

26 Haque, "Hardspace, Softspace," *Archfarm*, 3-4.

27 Galloway, Brucker-Cohen, Gaye, Goodman, and Hill, "Design for Hackability," *Proceedings of DIS*, 365.

28 Haque, "Hardspace," *Archfarm,* 4-5. See also Haque, "Social Role of Design," *Proceedings of Outside In*; Haque, Jacobs, Paterson, and Wolf, "Open Source Architecture," *Proceedings of RAM4*.

29 Goodman, in Galloway et al., "Hackability," 365.

30 Rowe and Koetter, *Collage City*, 6.

31 Rose, quoted in Till, "Impure," 72.

32 muf, *This,* 12.

33 Bødker, "Creating Conditions for Participation," *Journal of Human-Computer Interaction*, 373.

34 Broeckmann, "Subject: Urban Agencies," *Read Me! ASCII Culture*, 213-4.

35 Binder, "Intent, Form and Materiality," in *Social Thinking*, ed. Dittrichm, Floyd, and Klischewski, 453.

36 Binder, "Intent," 466.

37 muf, *This,* 29, 215.

38 See, for example, Fischer, "Meta-Design: Beyond User-Centered," *Proceedings of HCI*; Fischer and Scharff, "Meta-Design – Design for Designers," *Proceedings of DIS*; Giaccardi, "Metadesign as an Emergent Design Culture," *Leonardo;* Haque, "Hardspace," *Archfarm*. Cf. other related notions in design discourse: Jones, *Methods*; Sweet, *MetaDesign: Design from the Word Up*.

39 Binder, "Intent," 458.

40 March, Jacobs, and Salvador, "Designing Technology for Community Appropriation," *Proceedings of CHI*, 2126.

41 See Hill, "An Other Architect," in *Occupying Architecture*, ed. Hill. For related arguments see Rendell, "Doing it, (Un)Doing it," in *Occupying Architecture*, ed. Hill; Hunt, "Just Re:Do it," in *Strangely Familiar*, ed. Blauvelt.

42 March, Jacobs, and Salvador, "Designing," 2127.

43 See Sanoff, "The Application of Participatory Methods," *Design Studies*; Till, "Negotiation". Cf. Shah, "Open".

44 See the discussion in Tuters and Varnelis, "Beyond".

45 See Galloway and Ward, "Locative Media as Socializing," *Leonardo*.

46 Tarkka, "Labours of Location," *Proboscis Diffusion*, 11.

47 muf, *This*, 217.

Use
Participatory practice
Notes

Public Play Spaces

Use

Public Play Spaces

Public Play Spaces was a platform for creative work exploring the playful, emotive, and appropriate incorporation of technology in everyday public life.

Drawing on art and architecture, the focus was on developing design methods and prototypes as formats for catalyzing new engagement in the public arena.

Public space today seems to be increasingly privatized and policed. Technology in the public sphere tends to extremes: either large-scale infrastructures, driven for the most part by the media or private commercial concerns that are applied generically and universally, or; mass-market consumer products that separate, rather than engage, people in their local contexts.

In Public Play Spaces, we proposed that interaction design work today is perhaps too much focused on putting technology everywhere, ubiquitously and indiscriminately, in our personal lives and public spaces. To ask such questions and speculate on alternatives, we threaded such concerns through a series of projects, workshops, and events. Operating on the fringes of larger design and research programs, our initiatives intended to be provocative and personal, challenging people to reflect, participate, and act.

Asking different questions and engaging new viewpoints requires a reconsideration of conventional 'work'-ing methods. Rather than work contexts or workplace issues, as has typically been in focus in 'design methods' in technology and systems development, we were interested concerns and expressions that characterize everyday public life. Rather than myths of community or consensus, we were interested in emotional, tactical, and cultural approaches based on difference and action.

Drawing on participatory methods and experience prototyping, we expanded and challenged these with perspectives from other fields – 'play', as approached in art, activism, architecture, and performance.

As a platform for thinking and acting, rather than a comprehensive (or funded) research program, Public Play Spaces was developed piecemeal and, to some extent, parasitically. Since we were already engaged in a several technology and design research programs, Public Play Spaces was pursued as a rather obsessive sideline. It started as a series of informal internal conversations and evolved primarily as a series of events.

For example, the [fringe] collective tried to engage local artists and designers in exposing and discussing their own views and work. Underdogs & Superheroes evolved as a series of methodological workshops, with spin-off effects into other projects such as Static! as well as a university course. Within our other project work, such as in Sonic City and IT+Textiles, we investigated and injected related ideas. The 'Outside In' symposium culminated many of the ideas and formats explored over the duration of Public Play Spaces.

Public Play Spaces is more extensively documented elsewhere. [1] Brief accounts of three – from among many – projects developed in the program are presented here. These touch upon different aspects of participatory practice, pursued either in concept or method, or both: 'Sonic City', 'Underdogs & Superheroes', and 'Tejp'.

Scope
3 years, 2001-2004

Platform leaders
Margot Jacobs
Ramia Mazé

Sponsors and additional participants
listed by project

Sonic City

Sonic City explores mobile interaction and wearable technology for generating music in everyday life.

We designed, implemented, and evaluated a system that creates electronic music based on sensing bodily and local factors. Input from sensors measuring context and actions is mapped to the audio processing of live local sound in real time. An extensible, plug-and-play, and wearable prototype was developed, such that sensors could be configured by players during tests in the city.

Sonic City generates a personal soundscape produced by a combination of physical movement, local activity, and urban ambiance. Encounters, events, architecture, (mis)behaviours – all become means of interacting with, or 'playing', the city.

Our intention was to break out of traditional forms of music creation and listening, enhancing personal expression and encouraging new uses of the urban landscape.

Project team
Lalya Gaye (Viktoria Institute)
Margot Jacobs
Ramia Mazé
Daniel Skoglund (8Tunnel2)
and
Magnus Johansson
Sara Lerén
(IT University Göteborg)

Sponsors
Interative Institute (through IT+Textiles and Smart-Its), Viktoria Institute (through Mobile Life)

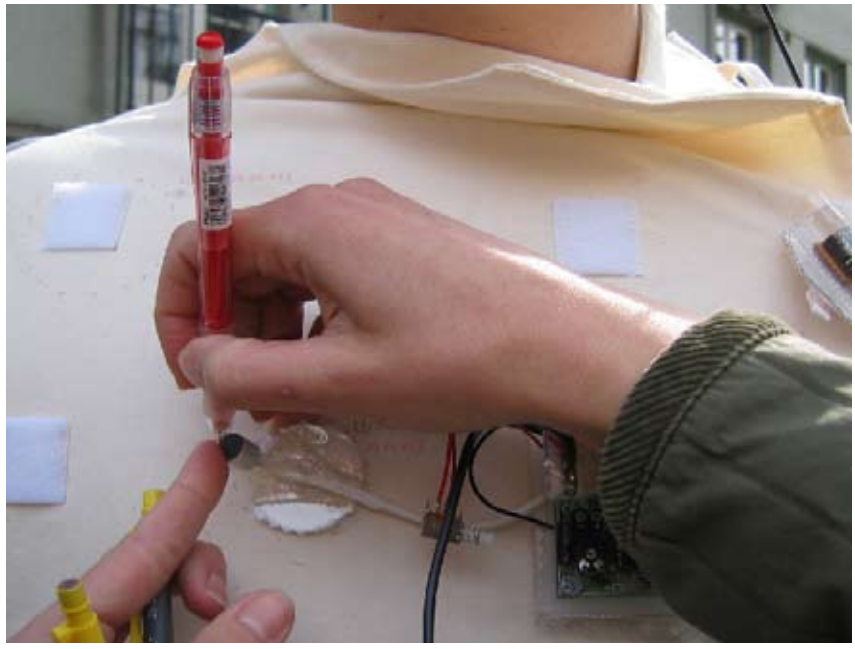
Process
The development process was guided by design methods and iterative conceptual and working prototypes. First, ethnographic observations involved 'staking-out' specific urban sites and 'stalking' pedestrians. This gave us new insight into familiar things and enabled us to imagine sequences of actions, events, and ambiances along a walk as a composition.

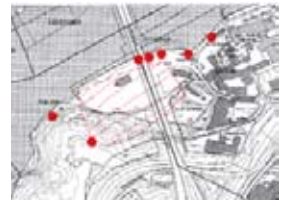
Then, scenarios of potential user experiences were generated, based on interviews and a workshop with practitioners of the extreme urban sport 'parkour'. These mapped out variables such as foreground versus peripheral attention, ambient versus rhythmic qualities, predictability versus randomness, player versus environmental control. In improv sessions with Daniel Skoglund, sound effects were manually triggered or 'performed' over video from urban observations. These were the basis for the design of alternate versions for user testing.

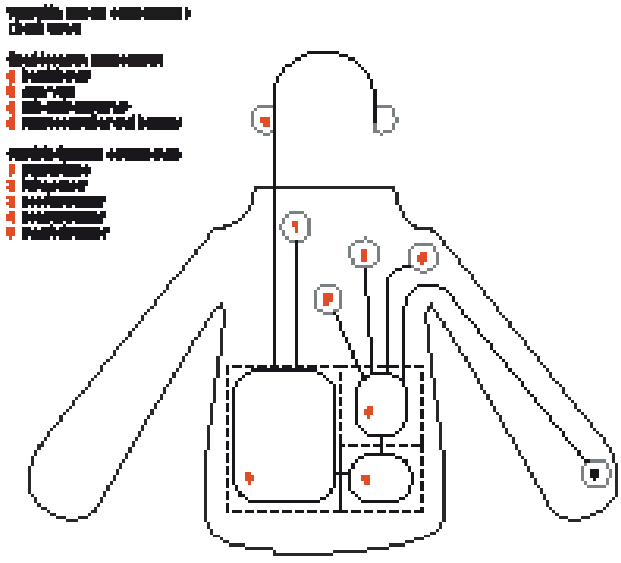
Outcome
Hardware includes environmental and biometric sensors, a laptop running the interactive music programming environment PD, and headphones. Live sound input from a microphone takes manifold paths through sound-processing objects. Sensor input is mapped directly to short events in the music and coupled with other sensor values to shape overall compositional structure. Effects include filters, delay loops, envelopes, sampling, playback, and echoes.

A wearable garment houses electronic components and allows players to 'try on' and easily change interaction, system, and aesthetic variables. The wearable was designed for choice over sensor configuration on the body, thus enabling a certain amount of control over the sonic form.

Extended on cables from the micro-controller, each sensor is encased in a plastic tab. Within a modular Velcro grid sewn on the garment, sensors could be easily relocated. While not optimal in terms of aesthetics and tidiness, this supported experimentation in testing situations. From test results, further design concepts were generated in a workshop with students in textile and fashion design.







Tejp

Basing the intervention of technologies on existing patterns of behavior and expression, *Tejp* is a platform for leaving personal traces in public space.

The project started with interviews with public artists and graffiti writers. Insights were gained into cultural aspects of such practices, the physical traces of which were transient and even overlooked by most passers-by. However, these qualities are meaningful within the values and social relations of particular (sub)cultures, reflected in the aesthetics, placement, and longevity of markings such as stickers and tags.

As a parallel but divergent 'system' of public communications, such practices inspired ideas about aesthetic and technological triggers for local interaction. The intention was not to impose technologies onto existing subcultural practices, nor to blindly transfer the qualities of such practices into larger technological infrastructures.

Instead, Tejp proposed 2 concepts for insinuating additional layers of expression and for enquiring into how such expressions might affect or reflect practices of use.

Project team
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Lalya Gaye (Viktoria Institute)
and
Anders Ernevi
Ramia Mazé
Tobias Skog (Viktoria Institute)

Sponsor
NIFCA, the Nordic Institute for Contemporary Art

Outcome
2 concepts were developed as working prototypes. Tejp 'Audio Tags' were adapted from off-the-shelf audio doorbells, fitted with a button for recording and proximity sensor. Passing by or leaning towards a Tag causes message playback – anyone can re-record the 10-second message and relocate a Tag, leaving it to be triggered by subsequent passers-by.

Tejp 'Glitch' broadcasts hidden layers of personal communication in public space. It picks up local electromagnetic interference caused by messaging or talking on mobile phones. Simply powered-on loudspeakers, Glitch attaches parasitically to metal objects such as sign-poles to sonically amplify interference patterns. For example, if arranged along a path, sonic glitches might publicly 'stalk' a pedestrian as they walk and talk.

Each concept positions locals as protagonists, their use of public space as expressive and performative practices.

The Tags were commissioned for installation in Rejkjavic, Iceland. Over three days, we observed playback triggered, often accidentally, in situations of waiting and passing by at the Hlemmur Bus Station. Discovery of and interaction with the Tags were sometimes public spectacles, sparking a range of interesting exchanges with or without recording new messages.

Even during this short period, new forms of social exchange and patterns of interaction were suggested. Messages were left in Icelandic, Swedish, English, Vietnamese, and French, including poetic, political, and religious statements. As in written graffiti, people often left their name. Exchanges via the Tags occurred, for example as a couple alternated declarations of love in a sequence along a street, and teenagers left opinions on a map.

Underdogs & Superheroes

Underdogs & Superheroes (U&S) developed a game-based design methodology. In contrast to the typical impetus of research or commercial projects, we did not start with a concept, technology, or business plan. Rather, we gathered and experimented with methods and actions to provoke open-ended and participatory discussion. A superheroic theme framed general topics of personal transformation and societal aspiration.

U&S drew together methods explored in previous projects, including those from game research, conceptual art, and experience design. Such a palette of methods expanded our repertoire of means for engaging participation in varied situations with diverse stakeholders.

Each game framed a time and space for strategic 'suspension of disbelief'. We found that games help imagination by representing reality without limiting expectations to the here and now; engaging experiential and personal perspectives; and opening creative processes to hands-on participation through low- or no-tech materials and a widely-understood approach.

We have since applied such methods for designing and for team-building in a range of institutional and professional contexts – for example, to engage stakeholders actively and tangibly in accelerated concept development processes. Additionally, resulting concepts have been spun-off into other design research programs.

Project team
Margot Jacobs
Ramia Mazé
and
Anna Dahlberg
Anna Götesson
(IT University Göteborg)

Games
Game formats and design materials were a basis for shaping the dynamics of collaborative processes. Early games were simple, focused on the parameters of specific techniques. Later, techniques were developed to shift between individual reflection and group negotiation. More important than discrete methods was choreography of placing and sequencing methods to involve variables of empathy, imagination, decisions, or competition.

{ Game 1 } Superhero survey: A correspondence format online. People were invited to download and share their aspirations for personal, societal, and urban transformation.

{ Game 2 } Automatic mapping: A psycho-geographic event. Inspired by Surrealist automatic writing and the Situationist dérive, walking became a poetic mechanism for brainstorming emotional connections across the city.

{ Game 3 } Public mapping: A participatory map locating sites for action and respite. Locals and visitors were invited to fill out and place colored question cards. Opinions formed as patterns of color and as individual stories.

{ Game 4 } Story of the object: A workshop. Through anthropologic 'excavation' of pockets and purses, the emotional and functional power of personal items was developed through stories and collective role-playing.

{ Game 5 } Superpower prototypes: Props for urban (mis)behavior. Participants used real and fictional properties of props to collectively problem-solve situations in an urban 'treasure hunt'.

{ Game 6 } Becoming a superhero. Overviewing games to date, various aspects were selected and enacted by members of our team as a means of analyzing and synthesizing methods, concepts, and sites.

The sections on 'Becoming users' and 'Participatory practice' explore concerns with respect to use and users. In particular, the form of technological objects requires use to unfold, since it is interaction involves a process of materialization, or giving form, to latent functionality. Interaction involves participation in unfolding the temporal form of computational and interactive processes. Participation has, of course, a history within design methods and user-centered design, art and technology, which naturally inflect interaction design located at the intersection of such diverse fields. In architecture and systems development, there have been efforts to opening up design processes and product form to increase stakeholder participation. Indeed, phenomena particular to the spread of post-industrial technologies, such as hactivism and tactical media, as well as user innovation and open source, directly challenge and blur the historical and power relation between production and consumption, 'designers' and 'users'.

Thus outlining some points from previous sections, certain issues come into focus. One challenge raised by increasingly blurred boundaries is how to construct processes and products that invite or provoke participation – and how this might position critical questions 'upstream' in technology development. This was one motivation for Margot Jacobs and I to initiate 'Public Play Spaces'. Originally coming from art and architecture, it seemed that in becoming interaction designers, we had become 'technologists'. In the various consultancy, corporate, and research contexts where we had worked, design was engaged long after the technology platform, business model, and product category had been decided. Our role as designers very often seemed to be that of integrating diverse requirements and targeting applications to particular domains of use. On one hand, we thought up 'future applications' for emerging technologies and, on the other, we delved into the realm of design methods. However, it seemed that we were most often addressing questions of 'how' – rather than 'why' – in technology development.

Use
Public Play Spaces

A variety of alternative positions seemed to be present, but disconnected from one another. Ethnographic perspectives, for example, seemed to offer rather deep and sometimes critical insights into (sub)cultural appropriation and 'domestication' of products into everyday life. However, in our experience, such perspectives were typically applied at the beginning of a design project, in a separate phase of user or site research, or after the project had finished, in a usability evaluation or field study. While we engaged in methods, tools, and techniques from Participatory Design (PD), respective ideological and political questions tended to focus on work and workplace issues. Artistic and critical methods, if applied, were often part of the personal repertoire of individuals, rather than integrated into larger research and development practices. Indeed, it seemed like social scientists, activists, and artists readily donned the hat of the technologist even in the most progressive of institutions.

Drawing on our previous experiences, we felt a need to develop a space that was more permeable and provocative, both with respect to joining diverse domains and for responding to what falls outside of them. On one hand, our interest in methodological issues had been challenged and expanded by our contact with diverse fields, including the social sciences, art, and performance. However, there seemed to little room within the time and space of traditional project work to understand how various methods might or should be related to one another. On the other hand, even when design seemed to play an important role in integrating and extending 'the library' and 'the laboratory' into the domain of use, we felt that there might be room for developing more and different kinds of interactions with the public realm and everyday life. Indeed, we felt that in design research there was an obligation to take on more challenging and experimental work in this area.

Public Play Spaces thus evolved as platform for posing such questions and actively trying out alternatives. To think about such issues and engage in experimentation, we tried to create a bit of distance from our conventional roles and even from our comfortable workplace. Rather than strategies of integration, we explored tactics of provocation and intervention. We left the confines of the studio to stage events and happenings in the public arena, and invited locals back into the studio and our projects. We continually struggled with the urge to take a concept and run with it, directing it into the form of a project and toward a more familiar closure. We tried to keep this as a separate and open arena, free of the structure and logics of other projects. Last but not least, we tried to have fun, generating enthusiasm and imagination inside the studio and out, and, in this way, embodying the open and speculative attitude that we wanted to encourage in the public sphere as well.

The following section reflects upon our approach, contextualizing certain issues from previous sections in relation to more personal and concrete reflections on the 'Tejp', 'Sonic City', and 'Underdogs & Superheroes' projects. While Public Play Spaces was developed and carried out prior to the development of this text, there are nonetheless some relevant afterthoughts and speculations that might be drawn out.

Use

Public Play Spaces

Design gone wild

Much anthropology – the discipline charged with the study of human behavior – used to be conducted by people even continents away. As Tim Plowman points out, "most early 'armchair' anthropologists received their information secondhand from soldiers, missionaries, and traders and they did not hesitate to occasionally engage in questionable induction and wild speculation." [2] Not dissimilarly, reports and studies may be delivered into design situations, the results of market or ethnographic pre-studies. Designers may often operate at a far remove from use and users – with very little idea of what happens as things are domesticated into everyday life and normalized into (sub)culture. Design as professional practice or research, as serious 'work', might have the effect of removing us too far from 'natives' in the 'wild' – that is, people in real life – allowing us to become too comfortable in our armchairs and 'work'-places.

Certainly within ethnography, issues of interpretation, action, and intervention have long been under reconsideration. For example, anthropologist Clifford Geertz uses the term 'thick description' to describe the murky layer of interpretation and the altered subjectivity that comes into play in direct observation. Within design and technology research, such issues have been topics in 'action research', Participatory Design, and 'participative technological evaluation'. Marie-Jose Avenier and Laetitia Nourry, for example, argue, "The interaction between observer and observed is an inescapable problem – but rather than viewing this as an obstacle to knowledge, it should be considered the opposite, as a means of knowledge and perhaps the only means." In their extension of action research as 'intervention research', they ask "how can we initiate and bring to life strategic actions which are co-designed and co-managed by actors having fundamentally different origins, values, and goals, and who, until then, had never made the effort to talk together?" [3]

Social science methods have by now become commonplace in a variety of domains. Even designers and engineers now seem to 'do ethnography' – it is not uncommon to see pages of transcripts from video ethnography or conversation analysis in HCI or design research publications. In these circumstances, it seems important to make a distinction between 'user research' – studying use and users often in terms of social science – and the concerns of 'design methods' within design research. Increasingly, designers engage a variety of methods to involve use and users, but more often in terms of empathy and inspiration rather than in quantitative or scientific terms. An alternative to turning designers and other participants into (likely second-rate) social scientists is to recognize an expanding range of user-centered and participatory methods, such as 'informance', 'experience prototyping', 'video scenarios', 'focus troupes', 'future workshops', 'design games', and 'breaching experiments'. [4]

Public Play Spaces experimented with ways of engaging directly and personally in public space and everyday life – to 'go native' within design and technology research. On one hand, for us, this meant stepping back from our traditional roles and concerns as designers and researchers in order to return to ideas from our backgrounds in art and architecture. We explored a range of design methods but reinterpreted or recombined these with those from other fields of practice. On the other hand, we tried to take such methods outside our studio and upstream of the typical design process. We tried to involve (sub)cultural concerns and diverse communities of practice.

Thus, we set off to engage 'participation' rather than 'use'. In Sonic City, for example, the design of the garment was meant to externalize control over a technical system, to expose it as something that might be actively (de- and re-)constructed rather than merely used. Such notions came to the fore in Underdogs and Superheroes (U&S)

– first off, there was nothing which people could become 'users' of. There was no application concept, technology platform, or business idea, as are often in place long before a design process is launched. Instead, we invited people to participate in open-ended processes in which they were the primary agents of invention and change. In this sense, we tried to speculate on how design methods and participation might be engaged outside and in advance of closed design processes or finished products.

Such an approach required us to rethink and adjust familiar roles as 'designers'. In Sonic City, we resisted closing the system off to participation in use or to pre-determining any particular product category. In the testing situation, roles were quite specifically assumed in the terms of 'staging' and 'performing' – 'pseudo-' rather than 'scientific' evaluation. In U&S, certain aspects had to be prepared in advance. For example, session preparation involved choices as to which methods to foreground and which to apply as icebreakers, social lubricants, or segues. More important than any single method was the choreography of methods and materials throughout a game format, which impacted factors of empathy, imagination, or social competition. Within the games, however, Margot and I tried to step back as 'authors' or 'leaders', in order to allow participant agency and collective momentum to take over.

Even as we stepped back from design in terms of attention to concept, form, and product thinking, 'identity' and 'packaging' became important in other ways. In Tejp, for example, the Tags were carefully designed so as not to intimidate potential participants or raise security concerns in public space. The heroic and comic project identity of U&S set the backdrop for 'suspension of disbelief'. Design materials were low- or no-tech – suggestive forms made from craft materials, object found in pockets or the city, or 'readymades' scavenged from house- and hard-ware stores. Formats such as Situationist maps, treasure hunts, anthropological excavation, and charades were mixed-and-matched. In this sense, we repurposed already designed things – far 'downstream' of other design processes – lending a strange familiarity, ambiguity, and irony as a backdrop for an alternate 'superheroic' reality.

Thus, design materials carried much of the role of guiding U&S. Worksheets set the tone through graphics and language, as well as explanations and rules. Openings were built into activities – as empty space in worksheets or spare time set for redirection. Thus, Margot and I could recede as leaders, along with associations of power or determination. In Game 5, for example, there was a moment when the treasure hunt took on a life of its own, where group momentum took over, changing the order of events and reinterpreting deliberately cryptic tasks. Our role as designers consisted of preparing a backdrop of physical materials and choreography of events such that 'production' and 'performance' could be taken up collectively.

For Avenir and Nourry, intervention research requires a 'principle of incompletion' – the 'projects' of individuals must be deconstructed in order to stage the 'ongoing construction' of common ground. They argue that "the end result of an intervention research project is not so much the testing of hypotheses, which are formed beforehand by researchers in concrete situations. It is, rather, to make new research problems emerge, and to create intervention situations which are likely to enrich the thinking conducted jointly or separately by researchers and practitioners along the way." [5] Our methodological focus in Public Play Spaces does not mean that we avoided the 'wild speculation' of early anthropologists – quite the contrary, we likely exposed more problems than were solved. Indeed, our main intention was to expand the range of perspectives and formats that might be involved in such speculation.

Power play

As a means of engaging participation, 'play' was central to Public Play Spaces. It was explored as a concept (for example, Tejp as a way for people to engage playfully with local expressions), a technique (Sonic City, quite literally, as a means to play the city as a musical interface) and in terms of theory and method (in U&S). Play and games have been explored rather extensively in art and architecture – for example, in the activities of the Situationists and in conceptual art from Surrealism to Fluxus, which have been particularly inspirational for our work. In Public Play Spaces, we found that games help engage people's imaginations by representing reality without limiting expectations to what's possible here and now; engaging experiential and personal perspectives (the 'whole' person); and opening the creative process to hands-on user participation through low/no-tech materials and a widely-understood approach. [6]

For our purposes in Public Play Spaces, play may be understood as voluntary action extending imagination in time and space, whereas a game creates a format for play to take place separated from ordinary life both materially and ideologically. Play can exist alone as a pure activity free of worldly constraints without past or future – similar in many ways to the 'willing suspension of disbelief', which Samuel Taylor Coleridge described and that has been widely applied in game, literary, and performance genres. For example, others' experience of public space were imagined in Sonic City by assuming the role of 'stalker', taking on the attitude of a 'private eye' or of artist Sophie Calle. As Johan Huizinga outlines, play absorbs the player intensely – emotionally, intellectually, and bodily. [7]

Play is a familiar modality in everyday life. In his 'theory of moments', Henri Lefebvre argues that the everyday is composed of a multiplicity of moments such as play, love, struggle – which each define and are defined by forms. [8] Each has specific rules, durations, partners, and stakes, affirmed through repetition. Intervening into these might be conceived as an act of design, art, or activism. Indeed, game design involves the determination of roles and rules governing play. In a game, boundaries or rules of time and space, of starting, completion, and turn-taking, must be observed. Like the applause marking the end of play-acting, breaking the rules of a game is like breaking a spell, shattering the illusion of immersion and a role temporally assumed.

As Margot and her colleagues Kristina Andersen and Laura Polazzi put it, "A game is a way to create another reality and allow people to enter into it." [9] A step beyond 'suspension of disbelief' is to 'actively create belief', as Janet Murray argues. [10] One way to achieve this is to increase agency through use and choice of artifacts – a greater sense of control is matched by increased enthusiasm and investment. In addition, as Roger Callois points out, "Games attain their goal only when they stimulate an echo of complicity." [11] Most games depend on social competition, provocation, and contagion – heightening emotional engagement. A game offers a generative framework, evolving on the basis of including immersive narratives, rules, and social factors for play to transpire.

It was such a framework that occupied us in U&S. Each game combined a range of spatial and temporal factors – rather unlike a typical design situation in which there is a more or less clear-cut hand-off between design and use, a boundary mediated by a design object meant to embody and communicate intended use. To some extent, we had established certain boundaries, such as thematic backdrop, design materials, and choreography of events. However, even these were designed to be open to interpretation and appropriation in personal and collective participation. In return, social dynamics were undoubtedly influenced by our own presence and participation. The games were characterized by overlap among determining forces – boundaries and

roles were blurred. Ultimately, it did not seem interesting to isolate or separate out roles and parameters, since in any case complete transparency seemed impossible – instead, we tried to experience what was generated out of such interplay.

What became clear was that rather than conformity to roles of 'designer' or 'user', participants brought a range of personal, social, and cultural experiences that were just as pertinent to the ensuing activity, if not more so. Games 4 and 5 were carried out in situations with strongly established social relations. Within the space and time of the game, however, alternative personality, gender, and power dynamics evolved. One participant, who ordinarily had a minor job and tended to be verbally reticent, evolved a personal story through persona and scenario techniques. This became a powerful and determining idea within the group dynamic – the person's role was transformed in the game and perhaps in the group as a whole. In Game 3, locals, seeing through the eyes of outsiders, became self-conscious and insecure, while those recently arrived took on the responsibility of representing the situation and initiating newcomers. While certainly not leveling roles or mediating a common consensus, certain alternatives were catalyzed within the framework of the games.

Games construct another reality, but one in which relations among roles and rules have practical, social, and power relations, just like life. Certainly, such dynamics exist in everyday life and in design work – however, games provide another framework for examining, acting out, and altering such relations. Indeed, as games overlap in real life and real spaces, as in U&S, there are new opportunities for exploring 'real' versus 'aspirational' ideas and artifacts – for overlaying 'what if' over 'what is' – and for experimenting with alternative scenarios that might result. Additionally, the suspension of everyday reality in the space and time of the game provides a context for altering social and power relations, as well situating roles and rules that might enable certain risks to be taken – and to be managed – personally and collectively.

Notions of play, thus, explore alternatives to issues of objectivity and intervention. Indeed, as play is explored in contexts of art and activism, such issues come to the fore. For example, Fluxus' challenge to authorship was posed in terms of art as 'infinite play'. They rejected metaphysical categories (of knowledge, of society), the basis for the idea that an individual, to effect change, must occupy a space outside of these. Creating 'boxes', games, and happenings, they proposed "the work (object/performance) as a supposed extension of the individual, can have no predetermined identity or even purpose exterior to the social order within which it exists." Such works were open or ongoing, overlaying and intensifying the existing – "Fluxus seeks to shift from traditional utilitarian based prescriptions to an open-ended, less evaluative participation in the processes themselves." [12]

Such open-ended approaches might, however, be easily accused of either over- or under-determining that which results. Indeed, neo-Situationist artists and activists critiqued Fluxus for merely plagiarizing methods from Dada, without the political intent or revolutionary potential – ironically, they were accused of being more 'design' than 'art'. At the time, Fluxus was more successful in Eastern Europe, where play was more transgressive. As their works were inseparable from the existing social order, were performed by non-artists, and continued indefinitely, categories of 'artist' and 'artwork' were broken down, rendered locally and culturally contingent. As they dissolved the bounded-ness of the traditional art object in spatial, temporal, and cultural terms, they also thoroughly blurred subjectivity/objectivity upon which basis evaluation, accountability, and intent might be more familiarly situated.

Questions of a similar nature might be asked of design, about participation. For

example, the extent to which others might be said to dictate the outcome of a design process might easily reduce design to merely serving or reproducing the ideologies of others – while less evident in technology, this issue is certainly debated in architecture. Another question might be the extent to which opening up a process or product diffuses the potential for critical or political transformation. As Richard Buchanan points out, "The shift in the direction of deliberation is inevitably perceived by some people as a weakening of culture, a sign of the loss of central vision and values, because vision and values are now an explicit subject of discussion." [13] Participation alters power relations, with a consequent need for reconsidering issues of determinism and accountability with respect to design effects.

As will be discussed in the next sections on 'Change' and 'Critical practice', perhaps we might consider other ways of conceiving of objects, less spatially than temporally conceived, but with no less powerful effects. Bruno Latour, who's ideas will also be further discussed, argues:

> It's clear that each object – each issue – generates a different pattern of emotions and disruptions, of disagreements and agreements. There might be no continuity, no coherence in our opinions, but there is a hidden continuity and a hidden coherence in what we are attached to. Each object gathers around itself a different assembly of relevant parties. Each object triggers new occasions to passionately differ and dispute. Each object may also offer new ways of achieving closure without having to agree on much else. In other words, objects – taken as so many issues – bind all of us in ways that map out a public space profoundly different from what is usually recognized under the label of 'the political'. [14]

Certainly, the reduction of Dada, Fluxus, or Situationism – just as reduction of early PD – to a collection of methods, tools, and techniques might suggest a 'neutering' of radical potential or political intent. In adapting such methods for purposes other than 'art', 'revolution', or 'workplace democracy', we wonder about such questions in Public Play Spaces.

Certainly, we are not alone in our adaptation of methods. Indeed, participatory methods seem to translate in very productive ways across domains and at different scales – from those of local activism and art, to system and industrial development, even to political deliberation, as participative technological evaluation employs methods such as citizen juries, deliberative conferences, or political role-playing at the level of international policy, far upstream of design. However, while methods may translate across domains of practice and at a variety of scales from the local to the global, ideology, power, and politics may not. This suggests we must seek new frames – for example notions of the 'connective' rather than the 'collective' to link across diverse scales, or those of 'strategies' versus 'tactics' for relating the terms of diverse domains of practice – which must be left as open questions for future work.

Three issues were drawn out in 'Participatory practice' to frame the problematics discussed in 'Becoming users' – 'objects', 'openings', and 'intervention'. These are extended here to loosely frame some reflections on 'Sonic City,' 'Tejp', and 'U&S'. This is done retrospectively, of course, upon a program and projects with particular concerns and conditions that circumscribed their original conception and progress. Thus, reflections are exposed as afterthoughts and speculations that are left open-ended, which may resonate with topics discussed in other sections of this text or as threads for future development.

Objects

Objects – in processes or as products – are central to discussions of participation in design. In PD, the 'cardboard computer' created a certain suspension of disbelief by playing down technical and feasibility issues. Low-resolution prototypes and low-tech materials establish an accessible basis for anyone to mock up ideas or sketch alternatives in a participatory session. This means that the material conditions in design processes might be considerably, and deliberately, different from those in implementation (a difference in 'design materials' and 'materials for design', to which 'technology as material' poses some challenges, as discussed in 'Material practice'). Indeed, the modularity and configurability of open source hardware and software entail that materials generated in participatory processes may transfer directly as 'raw materials' for crafting a final product. Such aspects begin to break down boundaries between designers and users, conception and execution, process and product.

Such potentials inspired us to imagine a more open and public conversation – and generation – of technological objects in Public Play Spaces. It also meant that we had to be even more precise about how we crafted and situated artifacts.

Artifacts in U&S staged the articulation of experiences and aspirations – to support people in reflecting and creating together. For example, 'found objects', in pockets (Game 4) or urban space (Game 5), helped, simultaneously, to 'keep it real' and suspend disbelief. In Game 4, a pencil case reminded someone of a past friendship while another's hat was attributed with the power of self-confidence – eventually, fused together with the power to "shred time dimensions!", the 'case-hat' became a prop for communicating certain forms and functions that addressed a shared aspiration. In Game 5, off-the-shelf readymades became 'superpower prototypes' – repurposed as provocations rather than solutions. Like the 'case-hat', 'the illuminator' and 'the reflector' were not understood as 'products', but props for collaborating.

In Tejp, objects were crafted with a particular orientation to public technology. Rather than comprehensive and centralized systems, 'micromedia' better describes the approach – limited, low-tech, and bottom-up. With the Tags, for example, the intent was not 'tech transfer' into the realm of street art and graffiti, nor 'cut-and-paste' subculture into mobile application development. The devices did not replace any existing system of expressions in the street nor did they attempt to integrate with larger, private systems. They were the building blocks for another, independent layer for expression and were crafted to appear as such. There was no centralized content management or memory to the system – mechanisms for management and monitoring would have to arise in use, if at all. The devices were cheap, off-the-shelf, and hacked. It was not important that they were original or unique, but that they should be available and open for anyone to use, even to steal or remake.

In Sonic City, we avoided confinement to any specific product category, such as

'mobile device', 'music player', or 'smart fashion'. While technological and design decisions had to be made in order to develop a prototype, we tried to keep as many factors open as possible so that interpretations and applications might emerge from testing situations. Thus, hardware was not approached as a problem of streamlining and efficiency, rather the opposite. A laptop rather than a PDA was used so that software variables could be more easily adjusted, and sensors were extended on long cords to enable 'plug-and-play' configuration. The 'lab-coat' aesthetics of the garment were meant to evoke an urban 'wearability lab'. Even the fabric was chosen to double as a working document – participants' choices as to sensor configuration were noted directly on the jacket. Thus, we tried to situate the prototype within a larger process, as a sort of 'design material' rather than a specific solution or final product.

Afterthoughts

Our challenge in crafting these artifacts was to achieve the right level of over- or under-determination. Certain refinements might stimulate imagination, but too much resolution or 'finishing' might give the impression that most decisions had already been taken – thus inhibiting participatory input. Additionally, since participatory and prototyping processes could be potentially endless, we had to prioritize. Since our intention in Public Play Spaces was to focus on contexts and cultures of use, we tried to follow a principle of 'just enough prototyping' in order to open up as much space as possible to enquire into what might happen outside or after design.

Modularity thus became an important methodological factor. In U&S, a palette of methods enabled associated artifacts to be rapidly deployed and mixed-and-matched within multiple sessions. In this case, slack and openings for participation were demarcated by means of artifacts that spelled out certain rules and staged the process – but that also exposed how much was open for imagination and invention. Likewise, much was left open in Tejp – each Tag was the same, with limited functionality and recycled technology. The focus was on making the devices as simple and cheap as possible, such that their content and distribution might be determined more by use than by design. In each case, modular technical and design solutions served as a method for enabling improvisation in participatory or public contexts.

In Sonic City, the prototyping process was more ambivalent. Since our concept suggested a rather complex solution and in-depth testing, many technology decisions had to be made and implemented in advance. The 'products' of this rather closed process were then put into another process intended to be more participatory. To invite participation, modularity was both practical and exaggerated. For example, plug-and-play was a technical solution amplified in the jacket design. In part, this was a reaction to the fact that the sonic content and mapping decisions had already been made – easily evoking a perception of a finished product. In order to shift perception away from that of a typical product usability test, we tried to open the process back up for as many alternative choices and as much experimentation as possible.

However, this did not solve the fact that bases for previous decisions – and the role of participants in really affecting and changing the project – were not clear. Rather than as a driving force in the project (U&S) or as sustained by participation (Tejp), participation merely seemed to be involved to answer questions of how, rather than why, the system might be used. In retrospect, there might have been different approaches to this issue. On one hand, we might have tried to implement a more open process from the start, by opening up and iterating ideas in a more participatory way – for example, employing methods from U&S or as we had done in other projects such as 'Mixers' and 'Faraway'. In addition, or instead, we might have simplified the technology (as in Tejp) or applied more conceptual means of prototyping (as in 'Nomadic Audio' [15]).

Speculations
How or when to separate 'design materials' from 'materials for design' in participatory processes?

How does the complexity of new technologies, and associated specialization, affect issues of accessibility and expertise in practice?

How might technological decisions – and the ideologies and values of a particular technology and a design team – be exposed or made apparent?

How to decide the parameters of 'just enough prototyping' in multi-disciplinary projects, in which multiple practices, priorities, and values might conflict?

At what points and to what extent might participatory methods need to be introduced in order to really effect a participatory process or product?

In the first case, we might have crafted a different process, in the latter, we might have crafted the product differently. Instead, we ended up in the rather frustrating situation that we had a very resolved, implemented prototype, but we had run out of time and resources to move this on into more in-depth design development or to produce enough prototypes such that real social and cultural effects might be explored. While our original intent was that it should not be about 'users' going about their 'real life' with a 'product', but about people as 'players' and 'participants' in re-shaping and testing the limits of an 'open prototype' – we ended up with a rather conventional involvement of user-centered design into a technology development process.

Openings

A typical way of conceiving of artifacts as open to participation is in terms of how easy or hard they are to access. Low-res and low-tech approaches may be justified in terms of enabling everyone to engage directly and hands-on, and also in terms of breaking down privilege given by skill and expertise – as in discussions within PD and of the architectural 'profession'. However, the increasing pervasiveness of technical knowledge and permeability of communities of practice challenge such terms – as illustrated by Pro-am, open source, and tactical media. Indeed, the harder systems are to crack, the more they may be targeted by hactivists. Another way of relating to a notion of 'hard' to access, use, or participate, besides that of knowledge and power on the production side, is in terms of what happens outside and after.

That is to say, we might recognize other values and relations produced within the 'softspace' of ongoing interactions, generated within cultures and practices of use. These may relate to design intent – or opposition thereto – but, regardless, determine the long-term sustainability of things.

A participatory design process inevitably requires and is sustained by participation, whether or not such commitment extends into use. Thus, U&S bounded a sort of alternate reality for extended speculation. We made up, built, and animated artifacts in the course of role-play and scenarios. In Game 4, for example, the 'case-hat' had an improvised spatial form – however, its more essential qualities of glowing, shape-changing, and reversing time were built up in enactments. In Game 5 'superpower prototypes' were prepared in advance – however, deliberately ambiguous physical or mechanical properties demanded interpretation, even as the game required collaboration. Individual participation and group dynamics gave meaning to found or improvised artifacts – in addition to potential applications, these also delved into possible rituals, behaviors, beliefs, and futures that might emerge through use.

On a basic level, Tejp and Sonic City also require participation. Messages must be input, devices distributed, and replay triggered. In Sonic City, rhythm corresponds to pace – if a player stops walking or moving, the rhythm is muted just as quickly and eventually the music fades away. In addition, because the sonic form of Tejp and Sonic City is inevitably temporal, each system depends upon ongoing use. Messages and music unfold in time – narratives might be built up from Tag messages distributed in space, and Sonic City soundscapes from the composition of variables along a path. Tejp and Sonic City are thus characterized by the space between objects. That is to say, it is the personal and social relations between objects, as joined together by embodied and cultural actions, that determine the temporal form.

Additionally, since environments and actions could never be exactly the same, or be combined in the same ways, the same path would always sound different with Sonic City. Each time – and through time – a unique composition would be evolved. Voluntary and involuntary actions, visible and imperceptible events, chance, choice, and

patterns all affect the sound – blurring the boundary between passive experience and active participation. The temporal form of Sonic City is thus a co-production, weaving together bodily and urban factors, whether explicit and intentional or accidental and incidental. We imagined that this might spark transformation of city life – emerging sonic subcultures, for example, might spark a renaissance of improvisatory performances on metal service staircases at the backs of buildings.

Our focus, thus could not be only on the threshold to initial use, but the personal, social, and cultural factors that might keep people actively participating in use. It was important to us that Tejp was low-tech and Sonic City open source. However, 'ease of use' was not our primary concern. In fact, some of the most interesting interactions were those characterized by surprise, discovery, and happenstance. Tags triggered by accident stimulated a local spectacle. Ideas about their use emerged out of conversations among strangers – including that of distributing a story in pieces throughout a space, which would build into different narratives depending on path. Besides such uses, it seemed likely that new social interactions would emerge, and such unexpected interactions and events provided insights into this.

Afterthoughts

In Public Play Spaces, we were not necessarily interested in accessibility and usability, but in what committed participation in use might be like, and what it might generate over time. The form of Tejp and Sonic City was not given in entirety or all at once – requiring embodied use and distribution in space in order to be meaningful – or, indeed, to be manifested at all. To the extent that each system was modular, users might choose to activate certain features or not, as they appropriated more or less of the system into their lives. Even as limits of time and resources entailed that Sonic City and Tejp could only be prototyped to a certain extent, it was central to our enquiry how wider social and cultural value would emerge as the system might attract a certain critical mass of users or as word spread throughout particular communities.

In both projects, the wider relevance and effects of the system would be generated over time, indeed perhaps over a rather extended period of time. Certainly, we gained feedback on the system design from testing Sonic City. Similarly, we gained insights through observation, conversations, and content left on Tejp Tags over several days. However, wider and longer-term were hard to intuit or predict – for example, how use might vary at different times of day and seasonal conditions, across different communities and locations, and – in any of these circumstances – over time. Assessment of such implications could simply not be based on individual interactions or limited tests, since the life of the system depended upon how it might be sustained and evolved by means of cultural practices of use over time.

Of course, in retrospect, we might have approached this differently. For example, such an enquiry should perhaps have involved long-term ethnographic or domestication studies. This might have been facilitated by simplifying the Sonic City system and producing both Sonic City and Tejp in greater numbers, to get a better sense of critical mass and cultures of use. Another approach might have been to 'open source' the production activity – disseminating the systems as kits to see whether and how interest, commitment, and use might evolve. A third approach might have been to draw in more diverse speculation. For example, methods from U&S might have been applied to generate more participation and future scenarios, with target groups, experts, or simply a wider spectrum of the public. While this would not produce definitive or quantitative information, it might probe into diverse communities, involve potential 'lead users', and ask the wider questions posed in Public Play Spaces.

Speculations
How to combine or trade off between accessibility and usability or challenge and discovery in use?

What might be evaluation issues with respect to the particular social and cultural qualities of temporal form?

How to design for critical mass and cultural practices before artifacts are available to be used?

How to consider differences between the production and distribution of things versus their actual ongoing and committed use?

If it is not so much a question of quantity, how might the quality and sustainability of meaningful interactions be understood?
And designed for?

All of these approaches would have required rethinking resources, priorities, and ownership, not to mention evaluation and validity for research purposes. However, this exposes the necessity of revising practices, methods, and criteria in pushing the boundaries of conventional research – usability testing of well-defined applications in controlled situations is simply not always possible or even relevant. Indeed, such conditions hardly seem to characterize 'the public', 'public space', or 'play'. The 'soft-space' beyond and after design practices and products is hard to imagine, much less evaluate – not to mention the problematics of 'design effects' and 'future use', as will be discussed in the sections on 'Change'.

Intervention

Participation in design entails that the values, abilities, and needs embodied or represented by those participating become determining forces. PD has traditionally taken existing contexts and communities as a basis for design. Rather than predicting the future, creating new markets, or inventing 'killer apps', focus is typically on extending the possibilities of existing things or intervening the new into established practices – resulting in characterizations such as 'incremental' and 'evolutionary', as opposed to 'innovative' or 'revolutionary'. In participatory processes, materials and artifacts form a basis for articulating alternatives, negotiating new relations, or transitioning to another way of operating. Stakeholders are involved in development, as well as in using and sustaining the things that result. Far removed from any objective social science, this is an inherently political process, carried out collectively by a limited number of people, with negotiated, and thus compromised, results.

Public Play Spaces projects evolved through strategies of intervention – through hacking or reconfiguring existing things, trying out new roles in public space, and inserting new systems into familiar contexts. Today, personal artifacts often have an ambivalent role in public – mobile phones and music players make private spheres more audible or visible to others. 'Foreign' objects or idiosyncratic behaviors in public space may appear threatening. There is less public infrastructure and more surveillance systems. In an environment of heightened tension between public and private concerns, these projects amplify the existing and intervene new expressions. Our concern was as much exposing such issues and the choices that ensue, as well as for negotiating new social and artifactual interactions.

In Sonic City, the body, as the contact surface between personal and public space, becomes a site for renegotiating one's relation to the city. Not limited to buttons, the interface extends over the whole body and engages the proximate environment. A light sensor worn on the sleeve, for example, picks up the interplay of light patterns from the sun filtered through trees overhead as well as the shadows of one's arm swinging rhythmically while walking. Thus, the body is not only the practical instrument through which external space is navigated but also where contextual and personal factors are interwoven – natural, social, and personal factors are simply sensed and amplified. The wearable system, thus, is an intervention or overlay on the surface of the body, generating a new expression of mundane behaviors.

Tejp also overlays another possibility for personal and social expression in public – however, distributing and leaving technical devices in public raises concerns. Thus, it was important that the Tags project a certain identity. The form of the devices, like their surprising sound, is intended to be playful. It was important that the devices appear inviting rather than technical upon first glance. They blend into the environment, until one starts looking for them. While plain in appearance, they give clues to their use (for example, the holes indicating a speaker) and a certain aesthetic identity (for example, through a subtle printed icon representing the project). Developing an

aesthetic that was not intrusive yet clearly designed was important, such that there would still be the surprise of discovery and an expression of playful invitation.

In U&S, combining suspension of disbelief with existing objects and urban spaces was central to exploring aspiration in the context of everyday life. The identity of the project, from graphic style, writing, and workshop moderation, was carefully thought through to set an accessible, optimistic, and playful tone. For example, the comic-style 'superhero survey' seemed to encourage participants to appropriate the format, manipulating the pre-drawn scenario boxes and storyline to craft their responses, adding drawings, photo-collage, and found objects. This format for reflecting personal identity soon became an essential stage in setting the context in all the games. Play and parody set a playful, even utopic, backdrop for subsequent action.

Afterthoughts

To the extent that ideas and power relations are already embedded in artifacts and practices in place, then the intervention of the new involves choices about perpetuating or changing the existing. In this sense, it presents an opportunity for reflection, imagination, redirection, and deliberation. For us, Public Play Spaces was a basis for reconsidering how to craft the conditions for debating and making such choices, whether carried out through designing a process or a product.

In these projects, presentation was critical. However, this was not so much 'packaging' in the (stereo)typical design sense of styling or selling predetermined ideas – but about articulating questions and provoking reactions. In U&S, a strong identity in terms of play, aspiration, and even irony set a clear tone and rules for engagement, while also clearly demarcating openings for participation. In Tejp, the challenge was to craft technological objects for public space that were not threatening but sparked new interactions. Thus, the Tags were designed to blend in, such that it was the messages, rather than the technology behind them, that came to the fore. Project identity and product language were thus carefully crafted to set the stage for use.

Public interventions were opportunities for trying on and testing out alternative roles. Tejp catalyzed local expressions and spectacles. Sonic City provoked new physical behaviors and unexpected journeys. Because Sonic City was clearly situated as a personal technology, we were able to be more explicit about how the system appeared in public tests, including the exaggerated 'lab coat'. The result was a rather theatrical situation that helped establish a certain suspension of disbelief, such that participants would feel free to play around and improvise. In addition to enabling participants to step into an alternative role in public, this also was a means of testing the reactions of passers-by. Intervening into the ordinary, the hope was that participants and spectators might become 'players', rather than merely 'users' of public space.

After a while in U&S, it seems that we began to focus too much on 'application' – of methods into processes and of ideas into designs. Somehow we had lost track of original questions. For example, at later stages in game activities, concepts tended to become not only more concrete but also more typical and superficial. Concepts began to repeat themselves across workshops – for example, various wristwatches with particular properties and technical solutions. As aspirations from the 'superhero survey' or 'found objects' were taken forward by groups, collaborative 'work' tended to become just that – solving practical issues, such as how things might function or be formed – rather than challenging one another by renewing questions about why.

While we wanted to move from conceptual to concrete in each game, it was not usability or feasibility that we wanted to be concrete about, but how creative and

Speculations
Where does 'participation' already exist or potentially intervene between the public and private spheres in everyday life? Between public infrastructure and consumer electronics?

On what basis are such relations negotiated, managed, and developed? Where does the power lie in making decisions?

How does the design of identity and packaging resist service to a particular ideology, but operate between or across points of view or possible futures?

When to focus on establishing collective understanding and dynamics, and when to develop external connections? Where do ideologies and values, methods and techniques connect or conflict in such a situation?

collaborative enquiry might translate into real world and public space. One approach to this was to shift the context of group work, redirecting developed dynamics of diplomacy and competition back outwards. For example, in a 'treasure hunt' format in Game 5, the group applied imagined or real properties of 'superpower prototypes' in the city. This shifted focus from better resolving relations or concepts, to extending, improvising, and testing still rather open ideas in less certain circumstances. Ideas were not yet fixed, nor minds made up – yet new conditions were brought to bear within a dynamic that was still emotionally invested and collectively committed. It was not solutions that emerged but a more intense and informed debate.

Shifting the boundaries, even within a design process, between who and what is 'outside' and 'inside' might have implications for considering relations between the 'collective' and the 'connective' – how individuals, groups, and the public might transition into one another, and what ideological and artifactual basis might facilitate shifts or transfer between. While we only started exploring such issues, in retrospect, it seems evident that participatory methods and processes might provide a platform not just for creating consensus around certain ideas or for designing better things, but for creating certain dynamics that might extend beyond design processes, into other public spaces or social spheres, in a more connective, if less collective, way.

Notes

1 For some background on themes in Public Play Spaces see [fringe] (website); Jacobs, ed., *Proceedings of Outside In*; March, Jacobs, and Salvador, "Designing Technology for Community Appropriation," *Proceedings of CHI*; Mazé and Redström, "Form and the Computational Object," *Digital Creativity*; Outside In (website).
For publications that Margot and/or I have authored on projects presented here see: Gaye, Holmquist, and Mazé, "Sonic City," *Proceedings of UIST*; Gaye, Mazé, and Holmquist, "Sonic City," *Proceedings of NIME*; Jacobs, "Tejp Audio Tags" (report); Jacobs, Gaye, and Holmquist, "Tejp: Ubiquitous Computing," *Proceedings of UbiComp*; Jacobs and Mazé, "Design-by-Doing," *Proceedings of PDC*; Mazé and Gaye, "Sonic City," *Proceedings of Cybersonica*; Mazé and Jacobs, "Sonic City: Prototyping," *Proceedings of ISWC*; Mazé and Jacobs, "Underdogs and Superheroes," *Proceedings of CAST*.
For more information including links to project pages and publications by our collaborators see Public Play Spaces (website).

2 Plowman, "Ethnography and Critical Design Practice," in *Design Research*, ed. Laurel, 31.

3 Avenier and Nourry, "The Sciences of the Artificial," *Design Issues*, 55, 59-60.
For related discussions see Reber, "Public Evaluation and New Rules," in *Making Things Public*, ed. Latour and Wiebel; Whyte, ed., *Participatory Action Research*.
For references on Participatory Design see the section 'Participatory practice.'

4 See, for example: Brandt and Grunnet, "Evoking the Future: Drama and Props," *Proceedings of PDC*; Brandt and Messeter, "Facilitating Collaboration through Design Games," *Proceedings of PDC*; Burns, Dishman, Verplank, and Lassiter, "Actors, Hairdos & Videotape," *Proceedings of CHI*; Buchenau and Suri, "Experience Prototyping," *Proceedings of DIS*; Bødker, Keld, Kensing, and Simonsen, eds., "Workshops," *Participatory IT Design*; Gabrielli and Zoels, "Creating Imaginable Futures," *Proceedings of DUX*; Crabtree, "Breaching Experiments," *Proceedings of DIS;* Iacucci and Kuutti, "Imagining and Experiencing in Design," *Proceedings of NordiCHI*; Mackay, Ratzer, and Janecek, "Video Artifacts for Design," *Proceedings of DIS*; Muller, Wildman, and White, "Taxonomy of PD Practices," *Communications of the ACM*; Sato and Salvador, "Playacting and Focus Troupes," *interactions*.
For an overview of user research methods see 'Participatory practice'.

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Notes

5 Avenier and Nourry, "Sciences," 56.

6 See also Andersen, Jacobs, and Polazzi, "Playing Games in the Emotional Space," in *Funology: From Usability to Enjoyment*, ed. Blythe, Overbeeke, Monk, and Wright; Mazé and Bueno, "Mixers: A Participatory Approach," *Proceedings of DIS*; Mazé and Jacobs, "Underdogs".
For related methods in conceptual art see, for example, Andreotti and Costa, eds., *Theory of the Dérive*; Brotchie and Gooding, *Book of Surrealist Games;* Friedman, ed., *Fluxus Reader*.

7 See Coleridge, *Biographia Literaria*; Huizinga, *Homo Ludens*.

8 See Kofman and Lebas, "Recovery and Reappropriation in Lefebvre and Constant," in *Non-Plan*, ed. Huges and Sadler.

9 Andersen, Jacobs, and Polazzi, "Playing," 161.

10 See Murray, *Hamlet on the Holodeck*.

11 Callois, Man, Play and Games, 39.

12 Smith, "Playing with Difference," *Fluxus*, ed. Friedman, 117.

13 Buchanan, "Branzi's Dilemma," *Design: Pleasure or Responsibility?*, ed. Vihma, 11.

14 Latour, *Making Things Public*, ed. Latour and Weibel, 15.

15 For more about 'Nomadic Audio' see the project insert in 'Becoming users'.

Use
Public Play Spaces
Notes

Change

Design effects

Design is about change. Whether solutions to problems, open-ended experiments, or critical alternatives, it is concerned with the transformation of existing reality. The ambition to construct a better future society was central to the modernist project – today, we continue to believe in design as 'making things better', to borrow Philips' motto, and as effecting 'Massive Change', as proposed by Bruce Mau. [1] Certainly, design in disciplinary and cultural terms must relate to past convention and current conditions. However, designers must project beyond the scope of a discrete design act in the present, making decisions and giving forms that determine possible futures. Design moves beyond accounting for what is, and what came before, to imagining and constructing what might be. Perhaps this is its most radical potential.

Design involves projection of ideas about 'what might be' into form, with substantial and long-term cultural and political effects. Since neither matters-of-fact nor laws of nature fully determine human and social relations, there cannot be a single or final solution to the things designed to mediate them. Designers make choices among competing ideas, proposing possible solutions. Deliberated by consumers at point-of-purchase, taken up into ongoing use, adapted within communities of practice, and sustained in cultural memory, forms effect change. Society is built both through the inscription of ideas into things – and the incorporation of these into bodily and cultural practices. [2] Design can be neither completely normative nor entirely neutral, involving ideas, choices, and intentions of designers, users, and many others.

Change
Design effects

While the ever-increasing range and functionality of products seems to promise ever more choice, freedom, and empowerment, to some extent this obscures how they determine ways of life. Victor Margolin has pointed out that the complexity of technological things is increasing users' dependence on 'product environments', including updates and add-ons, user manuals and customer support, subscription and warranty services. While some things may be based on 'open source' values, Langdon Winner argues that others might be intrinsically undemocratic. While arguments may be made for 'consumer democracy' through purchasing power, Jean Baudrillard argues that consumption entails entry in a system of buying into and perpetuating ideas set out by others. Just as design activity is ideological, the artifacts and interactions constituting lifeworlds are not neutral in mediating motivations and actions. [3]

Technological objects extend deeply into everyday life. Increasingly pervasive in personal, work, and public spheres, technologies take up space – and occupy time. Indeed, temporality is intrinsic to technological objects – in computation and interaction – entailing that the experiences of using such things is increasingly designed. Designed processes of interaction determine processes of use in discrete and repeat encounters, in diverse situations, alongside ongoing activities. As the spatial and temporal form of such objects are incorporated into practices of use, they become naturalized into ways of operating and thinking. Since the design of technological objects involves forming spatial and temporal relations, the act (and intention) of design extends to an even greater and more lasting extent into use.

Since the consequences of design lie in the future, design involves another aspect of time, that of 'futurity'. In addition to temporal form and unfolding interaction, future effects and change are central to interaction design. Technological objects incorporate spatial and temporal form ever more pervasively into everyday spaces and behaviors. In designing such forms, we must consider roles and responsibilities with respect to future use, since we are predetermining it to a much greater extent. Such issues require refreshing our understanding of agency and determinism, and of 'Critical practice', which will be discussed further in the following sections.

Powerful forms

Designed things play a powerful role in our activities and relations, shaping lifeworlds in quite fundamental ways. This power of design is at least in part by intent, as objects embody ideas and (more or less effectively) persuade us to think and act in certain ways. For example, products promise to ease our workload, embody the 'good life', signify 'taste' or social distinction, help us to fit in or to stand out in society. Indeed, to the extent that any artifact is created in order to shape, reinforce, or change behaviors, feelings, or thoughts, we might consider all designed things to be inherently persuasive. [4]

Richard Buchanan develops an account of the powerful and persuasive influence of artifacts through a notion of rhetoric drawn from classical politics.

> In this sense, rhetoric is an art of shaping society, changing the course of individuals and communities, and setting patterns for new actions. However, with the rise of technology in the twentieth century, the remarkable power of man-made objects to accomplish something very similar has been discovered. By presenting an audience of potential users with a new product – whether as simple as a plow or a new form of hybrid corn, or as complex as an electric light bulb or a computer – designers have directly influenced the actions of individuals and communities, changed attitudes and values, and shaped society in surprisingly fundamental ways. This is an avenue of persuasion not previously recognized. [5]

While there are various types of rhetoric, Buchanan is explicitly concerned with deliberative or political rhetoric – wherein the goal is to induce certain beliefs about the future. Since there are rarely singular solutions to human problems, solutions are always only probable and may be changed or set in opposition to others. Thus, design activity involves choices and makes arguments about practical life and human relations – "Design is an art of thought directed to practical action through the persuasiveness of objects and, therefore, design involves the vivid expression of competing ideas about social life." Through the form of things, he continues, design "attempts to persuade audiences not only that a given design is useful, but also that the designer's premises or attitudes and values regarding practical life or the proper role of technology are important, as well." [6] Design is inevitably ideological, embodying and even arguing for particular ideas.

Unlike classical acts of rhetoric, wherein speakers and audiences are brought together in speeches or other forms of communication, design objects are material ideologies. Such objects may be encountered partially, habitually, and over time, and their users may not constitute a captive audience. With respect to architectural objects, Mary McLeod posits their political power as embedded in everyday, habitual, even distracted use. She notes, "Owing to it's utilitarian value, its political impact may be more diffuse, if more sustained than that of other arts. Buildings are rarely perceived at once for their aesthetic qualities and 'content'; rather their impact occurs gradually through use and repeated contact. From this perspective, spatial configurations, tackle qualities and functional relations are as important as figurative dimensions in architectural reception." [7] Transformation of ideas and expectation happen gradually, through perhaps barely perceptible change of habit and course of action.

This notion of architecture might be extended to other complex and technological artifacts. Consider, for example, planning in cities, ergonomics in cars, and network coverage for mobile phones. Decisions have clearly been made and embodied in spatial form, whether to suit technical, economic, or societal ideas. As we engage with

and through such artifacts, our movement and access may be accommodated and constrained in various ways. We may not discover the extents of such accommodation except by making use of such things – by encountering blockages in the road, discovering the 'range of motion' built into things, or accumulating roaming charges in the next telephone service billing cycle. The ideology, or 'competing ideas', embodied in designed things are not always completely or immediately available.

Occupying time

Relations between design form, social control, and societal effects have long been the subject of study. Certainly, architectural form exerts power through sheer spatial presence – as Kim Dovey puts it, "All built form has inertia, it 'fixes' a great deal of economic capital into a certain form in a certain place, stabilizing spatial 'order' and 'identity'." [8] He has made a study of political power in built form with respect to aspects of coercion, seduction, and authority. Other examples of relations between ideology and form in architecture include Hausmannian Paris, 20th-century Manhattan, Nazi Germany, and contemporary Los Angeles. In particular, it has been Michel Foucault who has most extensively examined how the spatial form of cities and buildings has been central to maintaining 'disciplinary societies' over the last centuries.

In addition to considering the power of form to lie in their material presence and use over time, 'temporal regimes' are established alongside spatial ones. For example, industrial clocktime fixes and breaks down linear time into discrete parts that may be assigned to production goals. Today, with emerging technologies such as telecommunications and surveillance, 'control societies' are taking over from disciplinary societies. Paul Virilio, for one, analyzes the unlocatable and ultrarapid controls at work beyond immediate perception in technological systems. Foucault also analyzes the ways in which regulating power needs to contain unpredictability, the eruption of the individual or the 'event'. Indeed, Foucault is not so much interested in decoding ideological expressions or hidden meaning but articulating the conventions and practices through which power relations are produced and reproduced. Modern power, he argues, is productive and operates through the micro-practices of everyday life. [9]

Another perspective is given by considering the social and legal norms that govern everyday practices. Much of our use of buildings, cars, and phones, for instance, are constrained not just spatially but through temporal norms. Generally, we respect the rules of access and property, we stop at red lights and obey public signs, register our cars, and pay our bills when they come due, rarely reflecting on these expectations. Indeed, the origins of such regulation may be so far back in time that they may seem to be merely natural and inevitable 'facts of life'. Our use of the city becomes one in which both space and time are constructed for us – as Susan Silbey and Ayn Cavicchi point out, "drivers are bound together in a legally constructed space through which they are negotiating their way, literally and morally from one moment to another." [10] Often these behavioral and cultural norms go unnoticed and even 'disappear' as they are naturalized into our cognition and embodied action.

To the extent that the power of design may lie in processes of proximate and cultural practices of use, use may be seen as a process of bodily incorporation and social naturalization. Eric Von Hippel points out that in the introduction of any new technology or product, early on there is a fluid stage in which the nature, ideas, and use of such things are unclear. [11] In fact, users and communities of practice may be significant in examining and establishing the role of such things – in part, through active appropriation, tinkering, and even hacking. This notion is similar to that of deliberation and participation, as discussed in the sections on 'Use' and as explored in Buchanan's application of rhetoric. Such interpretation and even adaptation of

meaning, appearance, and functionality may even be re-incorporated back into the production of new things. For example, user-centered design and vernacular notions in architecture might incorporate iteration and evolution, even blurring the lines between the role of design and use over time. It is in time that a dominant and shared sense of what a thing is and how it should function becomes established.

Shifting to focus on 'Change', it is important to recognize certain limitations of the phenomenological accounts explored in 'Use'. Consider, as Foucault argues, "micro-mechanisms of power that… have played an increasing part in the management of people's lives through direct action on their body: they operate not through a code of law, but through a technology of normalization, not by punishment but by control, at levels and in forms that go beyond the state and its machinery." [12] Phenomenological accounts, such as those of 'place'- and 'sense'-making in architecture, often focus on the creation of meaning through embodied action and everyday experience, with a consequent tendency can to occlude the existence of things before and apart from subjective experience. This can result in blindness to the ideology and power inscribed in things and effects on our own cognition and bodily experience.

Forms of life

Far from neutral, designed things determine society in various ways, even as they are themselves ideologically shaped. Such topics have been central in the field of science and technology studies (STS). In the 1980s, sociologists of science argued that scientific discovery was not a systematic or autonomous progression towards the 'truth'. Instead, scientific knowledge and technology development were understood to be socially, even politically, constructed. Winner draws on architecture and urban planning to expose relations between power and form: "In advanced industrial society, relationships of power and authority are frequently expressed in material settings that are deliberately designed and built." [13] Just as patterns and processes of public and private life are continually reorganized and renegotiated through changes in the physical environment, they are also controlled by technological artifacts. 'Mere' objects and instruments might be better seen as powerful and political agents.

Change
Design effects
Powerful forms

Complex technical artifacts not only involve persuasion but participation. As discussed in 'Becoming users' and 'Participatory practice', technological objects require interaction to function in proximate use. Additionally, the role, function, and even form of artifacts evolve within communities of practice and are sustained through cultural use over time. Such interpenetration of technical, human, and cultural factors blurs distinctions between cause and effect, design and use. This notion is explored in STS as the 'social construction of technology' model of technological evolution. In such perspectives, meaning is understood to evolve depending on those that different 'groups with a problem' develop for it. For example, as Wiebe Bijker recounted, the bicycle was evolved by groups with needs of practical everyday function, racers and specialist users – even by 'anticyclists' who wanted it to fail. [14]

Within STS, accounts of 'actor-network theory' explore the agency and determinism of objects. Bruno Latour takes the example of a speed bump in the road. Such an artifact is a complex interpenetration of materials and intentions: "The speed bump is ultimately *not* made of matter; it is full of engineers and chancellors and lawmakers, commingling their wills and their story lines with those of gravel, concrete, paint, and standard calculations." [15] As such, the artifact takes on the agency of its makers, effectively "making a cop out of a barrel of wet concrete, lending a policeman the permanence and obstinacy of stone." [16] Latour and Madeline Akrich call the process by which artifacts act upon humans 'prescription', because not only do they affect actions and enforce social control – they exert power and moral authority.

Latour refutes a simplistic notion design determinism, of "an all-powerful human agent imposing his will on shapeless matter." [17] Akrich outlines a traditional view of design: "Designers thus define actors with specific tastes, competences, motives, aspirations, political prejudices, and the rest, and they assume that morality, technology, science, and economy will evolve in particular ways. A large part of the work of innovators is that of 'inscribing' this vision (or prediction about) the world in the technical content of the new object. I will call the end product of this work a 'script' or a 'scenario'." However, she complicates this – as this 'script' is translated into form and put into use, artifacts undergo a variety of subsequent and ongoing negotiations. She notes: "It is only when the script set out by the designer is acted out – whether in conformity with the intentions of the designer or not – than an integrated network of technical objects and (human and nonhuman) actors is stabilized." [18]

In her study of French-manufactured electricity generators in Africa, she observed that the technology was used successfully but eventually produced 'non-users', as 'prescriptions' of use in local cultural and social circumstances failed to achieve the social control needed for people to interact with them and keep them working over time. While Winner argues that certain technologies are inherently political, Akrich notes that "even in those cases where there are marked political implications, it is first necessary to interest and persuade the actors to play the roles proposed for them." She problematizes design determinism with a more complex account of the actors and agencies involved: "Although they point to an end, a use for which they have been conceived, they also form part of a long chain of people, products, tools, machines, money, and so forth." [19] It is only in use and over time that artifacts are (or are not) naturalized into cultural practices, to some extent irrespective of the original ideas intended and inscribed by their 'absent makers'.

Winner, thus, does not take artifacts to be unambiguous or finished entities. There are a variety of alternative solutions available to design – and as social actors (such as designers or users) make choices, things generally develop in terms of 'common use'. With respect to this complex interplay between determinism and agency, he develops an argument in which technologies might be seen as 'forms of life':

> The construction of a technical system that involves human beings as operating parts brings a reconstruction of social roles and relations. Often this is a result of a new system's operating requirements: it simply will not work unless human behavior changes to suit its form and process… We do indeed 'use' telephones, automobiles, electric lights, and computers in the conventional sense of picking them up and putting them down. But our world soon becomes one in which telephone, automobility, electric lighting, and computing are forms of life in the most powerful sense: life would scarcely be thinkable without them. [20]

For Winner it not enough to conclude that technology is socially constructed (he notes caustically that "reports of Martian constructions of technology remain largely unconfirmed" [21]). That is to say – it is not enough to do so without a conception about how different or alternative constructions might matter and what they might be like.

Future use

Like architectural objects, the design of technological objects unfolds over time. However, there are some critical distinctions. In considering temporal form and the form of interaction 'objects' of design – as we must in interaction design – we run the risk of trying to design future use. Therefore, we need to take a closer look at the scope of design and the extent of the design act with respect to time and 'futurity'.

The temporality of use in architectural objects is produced phenomenally, a result of choices about where to go, how to do so, and what to do within the built environment. The spatial form of architecture undoubtedly determines movement and perception, 'disciplining' behavior and experience. However, architectural design must also explicitly leave room for unexpected events (as discussed in 'Materials') and for evolving use and unpredictable users (as discussed in 'Use'). Within the blueprints and plans of a building, and within the urban infrastructure and zoning, space may be left open to the future, to what happens after the design act or even beyond design imagination. The more it works, the more it will be in a perpetual state of revision. Thus, as Antoine Picon points out, "Despite the attempt to improve the codification of design procedures in order to anticipate as closely as possible the final outcome, this relative indeterminacy is fundamental to the architectural project." [22] Future use is not amenable to determination or even to prediction.

Like architects, interaction designers must make decisions at one point in time based on incomplete knowledge of potential users and future use. To a much greater extent than in architecture, interaction design is concerned with form that will only ever be present in the future. Some aspects of technological objects, while conceived in advance by design, may not be perceptible except as they are revealed in active use and, indeed, may never be. For example, many of the functions in mobile phones are only discovered over time, through interaction with the user interface – that is to say, if they are needed or discovered at all. The form of technological objects is not only spatial but temporal, thus requiring acts of use to unfold. Designers must anticipate users' actions in order to design an artifact's reactions. Since technological objects may involve quite complex interactions between design and use, anticipating use and users becomes the subject of design to a much greater extent.

The temporality of use in technological objects is not only produced phenomenally, but must be anticipated and provided for by design. The temporal form of technological objects entails an intimate entwining of acts of design with acts of use. Interaction thus extends the scope of design even further into the time and space of future use.

The problem of the future

Since the use and consequences of designs lie in the future, design involves another aspect of time, that of 'futurity'. Not only must we ask, in interaction design, 'what does this artifact do', but we must have ideas about what a user might do in order to design what the artifact does next. Since what people do depends on what they think, where they are, and who they are, this opens up a range of new questions. Not only must we have ideas about design, we must have ideas about use – and such ideas cannot be based on knowledge about the past or present but 'what might be' in the future. Thus, we encounter the problem that data about the future – predictions – are hard to come by. Predictions require both a theoretical understanding of the phenomena to be predicted, or phenomena that are sufficiently regular that they can simply be extrapolated. Since the latter is rarely characteristic of human activity – that is, except in the most experimentally contained and limited contexts – our predictions can only ever be as good as our theories.

Given the particular concern of interaction design for use, we might understand why certain theories become so important. Perspectives from the social sciences such as sociology and psychology, for example, provide a range of important insights into potential use and users. The 'inscription' of ideas into things, such that they might be intuitively or easily 'interpreted' in use, is central in cognitive and semantic approaches. In such accounts, it becomes clear that design is not just about the function and utility of artifacts, but about models and theories for achieving a better 'fit' between design and use. Evaluation becomes important – not just for the sake of including people as participants in design processes or gauging customer satisfaction of products, but for measuring the transfer of design intent to error-free use, as in 'usability' studies. Such theories and respective methods gain importance not just for the purposes of improving design, or even for improving use, but for improving what might be called the 'ideological transfer' from design into use.

As the spatial and temporal distance between designers and users increases, so does the problem of ideological transfer. For example, consider the distant past of the legal or social norms governing our behavior in traffic. While these may be naturalized into our cognition and bodies, simply crossing national borders may cause ideological and even phenomenological breakdowns. Certainly, the temporal gap between design intent and eventual use might be bridged through 'inscription' in spatial form – speed-bumps, for example. Such artifacts exert agency both spatially and temporally, in order that actions (if not ideas) are transferred from 'absent makers' to 'occasional users'. However, neither clarity of norms, nor rigor of design, guarantee successful ideological transfer, as Akrich's study of electrical kits demonstrated. That kits' failure was attributed to different causes by designers and users (producers blamed 'misuse' – users 'bad design') only further exposes the gap between design intent and local interpretation, between original theories and future use.

Change
Design effects
Future use

There might be a variety of responses to such a problem. For one, there could be increasing emphasis on analysis, information, and systematic extrapolation of past or present use into predictions of future use. Indeed, the term 'futurity' might resonate with notions of futurology or 'futures' in business and economics, which are explicitly concerned with extrapolating past and present states into future predictions. While such information might be helpful, clearly human activity can never be entirely reduced to 'matters-of-fact' nor 'laws of nature' as in basic science. Indeed, such reduction may not even work in science – we must be wary not to fall into back into traditional mindsets that the STS approaches discussed here have critiqued. In such traditional accounts, it was thought that the production of future innovations might be might be systematized by a backwards reconstruction from previous success cases – 'replicable' in terms more similar to those of basic science. Since a variety of circumstantial and complex factors intervene in the 'social construction' of such artifacts, exact reproduction becomes impossible, and the effort unproductive.

Another approach might be to try and determine the circumstances of use and the actions of users to a much greater extent by design. As Johan Redström has pointed out, there are some basic practical and theoretical problems with this, and a questionable tendency in user-centered design towards 'user-design'. [23] In interaction design, the idea that designs can be optimized on the basis of 'fitness' is being expanded beyond utility or usability to include interpretation, understanding, and experience. He argues that overdetermining the 'fit' between design and use reduces the space for interpretation and improvisation. Ultimately, this is to the detriment of an artifact inviting people to become users at all. An over-estimation of the role of design or an overdetermination of use may obscure the fact that the meaning of things is generated in use and over time, rather than by design.

Speculations
What is the role and responsibility of design in delimiting concerns, prescribing methods, and determining ends in participatory processes?

Might design materials, project structures and physical objects under- or overdetermine outcomes?

What alternative uses, desires, and behaviors might be opened up after design?

How might interaction spark unexpected use, and how to consider this in design?

Mixers

Mixers is a project focused on communications within the University of the Third Age (U3A), a non-profit learning organization run by and for elders in London. *

Through a series of 6 user forums, we employed methods from participatory and experience design to involve members of the community as design partners.

The final system re-used the existing telephone system to distribute personalized and public announcements about classes and activities. Messages are accessed via a tangible interface, embedded within tables used for breaks in the lobby space.

The project was awarded an honorary mention in the Helen Hamlyn Research Centre competition on Age.

Scope
4 months, spring 2000

Institution
Computer Related Design,
Royal College of Art

Project team
Monica Bueno
Ramia Mazé

Tutorial support
Bill Gaver
Michael Fields
Stevon Ritchie
Tim Olden

Process
Long-term sustainability within the community meant considering not only needs, skills, and physical abilities, but social and cultural factors. U3A members who would use and run the system were our 'design partners'.

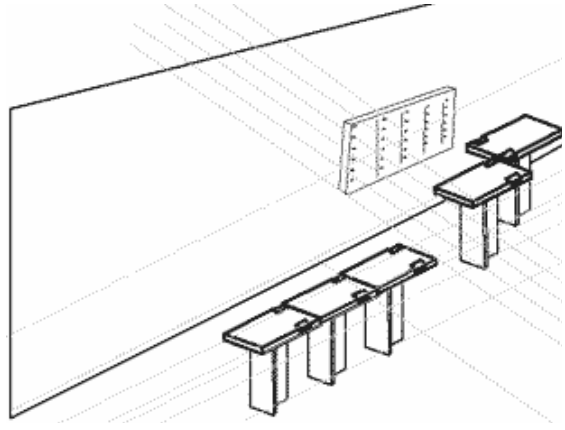
6 user forums:
- Starting a conversation
- Users as design partners
- Design through role-play
- Interaction in context
- Testing the design
- Final design

On- and off-site, design materials provided a basis for re-discovering and bringing us 'outsiders' into their personal habits, community values, and daily practices.

Some materials, such as conversation cards, were deliberately provocative to test pre-conceptions. Role-play facilitated suspension of disbelief even on site. Mock-ups in lo-fi materials enabled direct, hands-on modification by all. Even the final working prototype developed as technical and material modules – thus overlapping 'design process' with 'product production', and extending participation into both.

Proposal
Mixers extends the existing U3A information system, consisting of a noticeboard and informal sociability.

Glowing to invite attention from a distance, tangible audio interfaces face one another across coffee tables, with speakers that might also be shared. The school ID activates the system – one side for personal notices, the other for public announcements.



In attempting to address the problem of future use by such means, we run the risk of obscuring quite basic issues about the scope of design. As complex technological objects 'occupy time' to a much greater extent than other artifacts, interaction design must to some extent script processes involved in their use. However, the design of interaction must not be confused with the design of users or of future use. The problem with trying to understand and design for future use is that we might start to think not just in terms of what people 'might' do to what they 'should' do. Rather than fostering competing ideas, persuasive design might cross the line into determination – or coercion. Margolin points out, "Even as new technology generates products that are friendlier to the user, however, their complexity increases the user's dependence on a specific product environment." [24] We must be careful not to confuse the intertwining of design and use in interaction with the production of 'users' in the most unfortunate sense of dependency.

Myths of totality and utopia

In design history, recurrent themes of 'total design' and 'utopia' involve the extrapolation from 'what is' to 'what might be' – even 'what should be' is projected by means of utopian visions, science fictions, or 'good design'. [25] We do not have to look to far to expose the certain problematics of trying to design 'future use'.

There are many examples, particularly given the social project of modernism. For example, the Bauhaus movement extended the ideal of Richard Wagner's 'total work of art', as an attempt to renew the integration exemplified in past Gothic cathedrals. Joining diverse fields of artistic and industrial production, their socialist ideal of the 'cathedral of the future' would unify all workers behind the 'oneness of a common idea'. This unity was enforced by certain 'laws of design' that were at the center of Bauhaus education. From the universal master plans of the International Style, to the Situationists' New Babylon, to the Disney Corporation's town Celebration, the history of design is populated with totalizing visions of the future, whether based on metaphysical, societal, economic, or political ideals. [26]

Not far removed, contemporary 'experience design' aims to create seamless, immersive, and total experience. Nathan Shedroff expresses this idea: "Consistency is also important among related experiences. Branding is built successfully, for example, when different experiences, often in different media, feel consistent and connected. Again, what is important is the cognitive level of consistency – that is, that the experiences feel similar and related even if the details are quite different." Shedroff draws on Brenda Laurel's notion of theater and B.J. Fogg's notion of 'persuasive design' to develop principles for products ranging from websites and services to theme-parks and hotels. He continues, arguing, "Most designers of digital experiences dream of building an experience so immersive that the participants regard it as all-encompassing and forget that the experience may be artificial." [27]

While certainly complete 'suspension of disbelief' is appropriate and desirable in certain circumstances, 'total design' illustrates a larger problem of reducing users' critical distance and overdetermining the contingencies of future use. Shedroff seems to imagine that everything is available to be known, and thus controlled, by design – "The elements that contribute to superior experiences are knowable and reproducible, which make them designable." [28] He suggests that even inconsistencies should be designed in, for the sake of consistency with 'life-experience'. As Mark Wigley points out, even in projects that make claims of indeterminacy and incompletion, "Every potential gap is labeled 'gap' and therefore brought back into line." [29]

Taken to the extreme, 'total design' perpetuates a myth that design might provide complete resolution – or, in more sinister terms, a 'total solution' – to present differences and future eventualities. Clearly, any such idea is complicated by the issues discussed above. However, particularly as interaction design draws from various design and cultural domains, we must make distinctions with respect to the role and responsibility of design in determining change. If we understand that design and technology, our bodies and culture, are part of the field in which ideologies and power relations play themselves out, we might rethink the role and responsibility of design.

The discussion above suggests that design is not a simple matter of reproduction of the existing, extrapolation from the present, nor transparent ideological transfer. It deals not just with analysis, theories, and projection, but also the creation of the new and transformation of the future possibilities. Unexpected effects and unforeseen phenomena are produced by design and by things that fall outside of or after design – that which Diana Agrest calls 'non-design'. While certainly 'total design' has its place (not the least of which is demonstrating ideological and historical contingency), it is also important to expose inbuilt assumptions and develop competing perspectives.

Change
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Future use

Non-design

In the 1960s, architecture had a crisis with respect to its power to effect change. The International Congress of Modern Architecture (CIAM) that, since 1928, had set out principles based on humanist ideals of civil order and tidy categories of work-leisure-transportation-home had fragmented in the face of the existential, anthropological, and populist challenges of a new generation. Additionally, perceived failures of the modern movement began to surface. Mass-housing projects were failing and advocacy planning was losing rather than gaining momentum. The social ideals of modernism had dwindled with compromises necessary for rapid building on a mass scale and with its appropriation as a corporate style. Within an increasingly 'total system' of global capitalism, distinct alternatives were diffused, along with previous ideological bases for 'criticism from within'. A general sense of impotence within architecture found company in the postmodern 'death of the author' in literary studies. As ideas of social progress were displaced from architecture and design onto the market and technology, architecture was left without a clear agenda.

A vivid discussion of meaning and ideology emerged – how might design create meaning or change behaviors, and what did it mean to do so? This prompted inquiry into the autonomy, boundaries, and responsibility of architecture. In this context, Diana Agrest raised a notion of 'non-design'. [30] She proposed that if design can be seen as a cultural system with a distinct set of normative features (distinct practices, techniques, and theories, for example), then that which falls outside constitutes a system in itself. That is, 'non-design' might constitute a broad territory of alternative production and forms of occupation – even those that are, she suggests, delirious and carnivalesque. Non-design represents a view within an established discourse where design is not viewed as totalitarian, but merely one of many interrelated systems for producing culture and meaning, and, as such, its boundaries are seen to be permeable. Rather than a retrenchment into autonomy or abdication of responsibility, it suggests a basis for critique and negotiation of systemic boundaries.

At the time, various counter-movements and even the seeds of deconstructivism were emerging. These exhibited characteristics of critique and activism, whether in theoretical terms or 'in the field', as an explosion of experiments by groups such as Archigram, Superstudio, Non-Plan, and others. Such approaches shared an interest in developing 'open-ends' in architecture. They reconsidered the boundary between design and use, developing critical and alternative processes, objects, and forms of production. This section takes 'non-design' as a theme to frame a closer examination of various approaches to questioning the responsibility and effects of design.

Conform, reform, or contest

An important exhibition on Italian design at the Museum of Modern Art in New York in 1972 surveyed the ideas and works of designers who, "despairing of effecting social change through design, regard their task as essentially a political one." [31] Its curator, Emilio Ambasz, characterized three attitudes – conformity, reform, and contestation – as alternative standpoints within the crisis in design at the time. While engaging theoretically and politically, the activity of designing and design objects in themselves were nonetheless seen to offer particular possibilities for "active critical participation" in larger ideological systems. The consequences of design did not go unnoticed by designers or users – rather, effects were exposed, and alternatives explored in discourse and in action. Related trends in 'anti-design', 'Non-Plan' and 'post-functionalism' illustrate such attitudes and approaches here.

Anti-design

The 1960s witnessed an explosion of anti-design experiments, originating in England with Archigram and in Austria, questioning relations to wider developments in society and ideology. In Italy, anti-design built on a long national tradition of artistic and political discourse in design. Alchemia and Memphis promoted emotional play and symbolism over function, drawing attention to assumptions of utilitarianism and consumption. Adopting a 'super code of conduct', members of Superstudio dressed and acted as traditional architects, but along the way injected 'super-operators', or radical ideas and designs – "the architecture of superproduction; superconsumption; superinduction to superconsumption; the supermarket, superman and super gas." [32]

While Superstudio believed design must be concerned with society – "Otherwise we will end up by designing beautiful electric chairs or mountains of rubbish" [33] – they recognized that furniture and product design could not solve real societal problems. They argued that design problems were only set once ideological positions and societal behaviors had already been codified. Merely furnishing answers to rigidly stated problems and employing conventional instruments of practice, any real upheaval or alternative would be impossible. They proclaimed: "If design is merely an inducement to consume, then we must reject design; if architecture is merely the codifying of the bourgeois models of ownership and society, then we must reject architecture; if architecture and town planning is merely the formalization of present unjust social divisions, then we must reject town planning and its cities... Until then design must disappear." [34] They imagined a 'life without objects', developing design proposals as a critique of meaning, status, and other attributes of power.

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Superstudio pursued design as politically and socially-aware action, with objects as catalysts. For example, extending the 'sit-in' – "What we want to do is lay the foundations for an existence that is one long protest: a 'be-in'," they imagined total involvement rather than 'total design' – "Such total involvement may be achieved in two ways: by supplying products that are poetically functional or by supplying patterns of behaviour. In the first case you supply multi-significant (ambiguous) products, objects of universal use, and each user puts them to the use he thinks fit. In the second case, you supply the rules of a game to be played with all kinds of objects, or containers that can be filled with all kinds of things... (a stage of a continuous performance or, in other words, a place for happenings, a place for the be-in)." [35] Designed with an irrational excess or ambiguous lack of possibilities, such objects would require interpretation, reconfiguration – even protest – in use. Superstudio hoped, "When design as an inducement to consume ceases to exist, an empty area is created in which, slowly, as on the surface of a mirror, such things as the need to act, mould, transform, give, conserve, modify, come to light." [36]

Employing the resources and skills they had been educated with as designers, they produced products and a series of texts, models, and conceptual proposals. Their proposal for a 'Continuous Monument' was a transparent, gridded volume that might subsume the planet, interrupted only by mundane activities such as picnics and an occasional mountain peak. In its ubiquity, architecture would become transparent, an instrument for carrying out total uniformity, whether in service of egalitarianism, technology, culture, or other forms of imperialist ideology. Kenneth Frampton recognized design taken to the logical extreme of its service role, reduced to "an architecture that was virtually invisible, or, where visible, totally useless and by design auto-destructive." [37] Producing images and even products in the aesthetic of the Continuous Monument, the group carried their critique from concept to form. Their work was anti-utopic, neither serving ideals and problems imposed from the outside, nor refusing to design – instead applying design as 'problem-finding'.

Non-Plan

When 'Non-Plan: An Experiment in Freedom' was published in the New Society journal in 1969, it sparked outrage and stunned silence. Written by Reyner Banham, Paul Barker, Peter Hall, and Cedric Price, the article was a radical proposal for revising planning in the UK. It was prompted by emerging awareness of, on one hand, negative effects of modernist tower blocks and neighborhood demolition for planned housing estates and, on the other hand, flourishing American speculative developments such as Levittown and Las Vegas. Published three years before 'Learning from Las Vegas', Non-Plan shares a social-anthropological perspective, critique of 'good taste', and critique of top-down social determinism by design. Comprehensive planning was considered insufficient to deal with the rate of change and myriad needs of large, dynamic populations. The non-planners and their contemporaries shared a commitment to 'open ends' in design, doubting the possibility or desirability of any one authority to "identify the social 'programme' lying behind the design process, let alone cleanly 'resolve' it into 'a visually comprehensible whole'." [38]

Instead, Non-Planners imagined a spontaneous bottom-up order would be generated (or provoked) once planning mechanisms were removed. They developed scenarios about possible effects of eliminating zoning, preservation orders, and paternalistic welfare legislation. Removing planning policies, they argued, would expose social and economic forces masked by socialist modern planning – for example, "taking the lid off planning procedures in the Constable country of the Hertfordshire-Essex border would produce a situation traumatic enough... to show how much is genuine concern for environmental and cultural values, how much merely class panic." [39] In reducing design, they imagined other forces coming into play – whether these were underlying conservatism, free-market Darwinism, or emancipatory participation, was not the responsibility of design. Non-Plan was implemented in various incarnations, for example as 'enterprise zones' in London's run-down Docklands, which thrived under exemption from many planning restrictions and taxes.

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Non-Plan associates Archigram took 'society finding its own form' to another extreme with their instant, plug-in, and living cities. In a series of conceptual projects, presented in a style drawn from pop art, advertising, and science fiction, they designed 'pods, blobs, blebs, globs, and gloops' for local, nomadic, and collective use. Their winning entry in a competition for an entertainment center in Monte Carlo crossed circus, theatre, sports, and other programs in an open 'service, circulation and event space'. Standard service modules (coat- and rest-rooms), bleachers, screens, and stage elements could be rolled out on command, assembled to form anything from an art exhibition to a hockey arena. There was no predicted program nor fixed infrastructure, only standard, mobile 'kit' for public use. Service outlets at six-meter intervals offered 'telephone-parasol-airbed-fan-TV' appliances for hire, and television cameras were trained ubiquitously on the stages and the crowds, broadcast for public consumption. In their own words, "Archigram injected flexibility with amphetamines and envisaged adaptation on a daily, if not hourly, basis." [40]

Adhering neither to market, technological, nor political logics, Archigram extended possible futures to the extreme. While not politically revolutionary, like anarchists in the contemporaneous 'Guerilla Architecture' movement, they were aesthetically and socially radical. While remarkably (and unfortunately) uncritical of the technological determinism in their own work, they did go beyond mere 'tech-transfer'. Their designs were intended as mere scaffolding from which a new territory of socially and popularly determined programs might expand. Combining organic, mechanic, sensory, and computational elements, they reconfigured not only the functional but the psychedelic programmatic possibilities available through open-ended design.

Post-functionalism

Postmodernism opposed modernism's universalizing tendencies in method (mass-production) and aesthetic (the 'International Style'), its initial proponents advocating a return to the communicative and cultural role of architecture. In contrast, a second wave posited the impossibility of consensus and the disintegration of communication – rejecting traditional bases for dealing with a fundamentally changed human condition, they sought an orientation outside humanist ideals. Deconstructivists took notions of fragmentation, dispersion, decentering, schizophrenia, and disturbance as devices to dismantle and reconfigure architectural norms, as embodied in formal conventions such as the grid and program.

Peter Eisenman argues that 'modernism' never fully arrived in architecture, that the divine and natural orders of the 15th century were merely substituted with function and 'type' as a myth of origins, the content of antiquity replaced with that of utility. Thus, representation and meaning in architecture were merely false traces of humanism that, in other fields, had long been discounted with modern scientific, mathematical, and psychological discoveries. In contrast, his objective was "architecture as independent discourse, free of external values – classical or any other; that is, the intersection of the meaning-free, the arbitrary, and the timeless in the artificial." [41] Discounting both typological and cultural approaches, he embarked on a series of diagrammatic and built experiments to investigate the configuration of spatial relationships that might be considered archetypical – "that is, pertaining to the basic nature of space itself and to our potential capacity to conceive these relationships." [42]

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In a series of houses that systematically inverted conventions, Eisenman questioned, "What was a façade? Why should it be on the outside?" [43] In House VI, built in 1975, the horizontal datum is displaced from the ground plane, signaling a series of formal inversions as elements are shifted, visually and spatially, 'right side up and upside down, inside out and outside in'. It was "an alternative process of making occupiable form... a process specifically developed to operate as freely as possible from functional considerations. From a traditional point of view, several columns 'intrude on' and 'disrupt' the living and dining areas as a result of this process." [44] Thus, such formal experiments were also experiments in interpretation and use: "This work is an attempt to transcend our traditional view of: designing, seeing, understanding – our environment. It is an attempt to alienate the individual from the known way in which he perceives and understands his environment." [45] His 'post-functional' approach positions inhabitants not as users or observers, but as 'readers', conscious of the formal and conceptual ideas built into form.

The process of designing, as the configuration of spatial relationships, is made explicit in his buildings, superimposed – and imposing upon – inhabitation. Eisenman calls such works in which process and form are overlaid 'cardboard architecture' after the material typically used in preliminary models. Positing even built works as diagrammatic or prototypical, such design stops short of projecting anything outside the formal act. Leaving use open, he aims instead to frame a sort of conceptual occupation. He states: "A conceptual structure is that aspect of the visible form, whether it is an idea, in a drawing, or in a building, which is intentionally put in the form to provide access to the inner form or universal formal relationships... In order to approximate a conceptual intention, the shapes which are perceived would have to contain a structure within their physical presence which would have the capacity to take the viewer from the sense (immediate) perception to a conceptual attitude, and at the same time requiring of this structure a capacity to suppress the possible primacy of a sensual response." [46] In such projects, Eisenman negates conventional forms of design and use, positing a 'theoretical object' in place of a functional one.

Speculations
What political and societal aspects of use should be considered in design – and vice versa?

How might design intervene without overdetermining or losing relevance in the future?

How might design indicate that further action and change can – and must – take place?

How might design provide a framework for the most significant action to be taken in use?

Street Signs

Street Signs is a concept for a physical and service infrastructure to be shared and run by multiple community groups in East London.

The design proposal includes 3 architectural and product interventions. The strategic component is a service scheme for lending, maintaining, and funding use.

Each intervention combines elements that are already in place, off-the-shelf or recycled, to serve a particular social, informational, or economic purpose for the groups. As small-scale and 'vernacular' designs, they may also be combined in an ad-hoc way to create a larger synergy in the borough and to ensure ongoing sustainability.

Scope
3 weeks, spring 1999

Institution
Computer Related Design and Architecture departments, Royal College of Art

Project team
Ramia Mazé

Tutors
Fiona Raby
Liza Fior and muf Art + Architecture

Process
Within the parameters of a grant scheme by the Millennium Trust, Street Signs was based on pre-existing and sharing resources for large, long-term impact on a budget.

Alongside secondary research and stakeholder discussions, I adopted roles – that of 'social auditor', 'town planner', and 'anthropologist' – to discover cultural expressions, makeshift practices, and informal patterns layered within public spaces and regulatory frames.

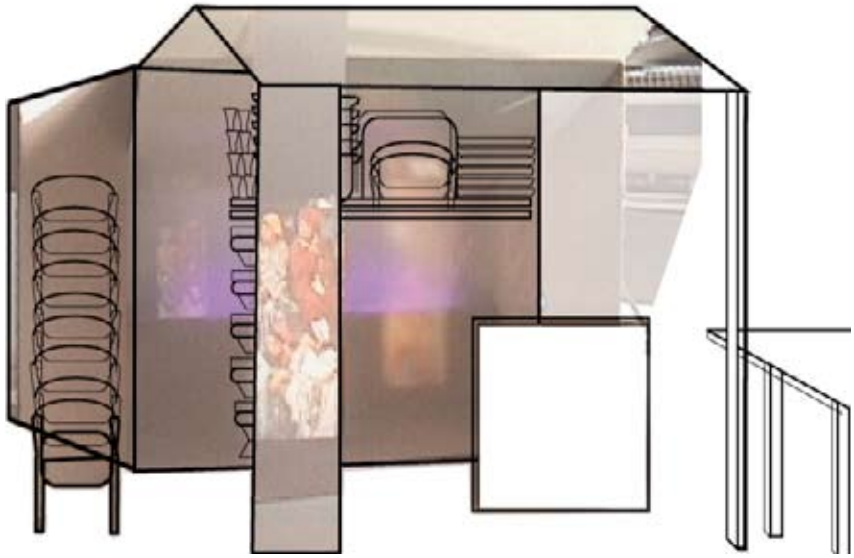
Proposal
The proposal involved both designed and strategic components. Strategically, an existing public library initiative was proposed as a basis for centralizing and pooling common resources, and for promotional and funding purposes. Volunteer or part-time staff could help develop critical mass and a sustainable outlook for diverse groups.

3 design interventions were proposed, centered on three typical community groups. Found objects were recycled as raw materials, existing formats and local skill-sets were extended for financial and social feasibility. Possibilities for secondary use and economy such as ads, rental schemes, and resource time-share were suggested.

- Women's Aid. Thermal-roll fax machines are repurposed as information displays in local storefronts, such that ad-hoc activities may be posted instantly and in any language.

- La Paila. An assembly kit includes a truck, tent, and restaurant equipment. Fitted with a modified slide projector and ghetto blaster, cultural and fund-raising events may be personalized and staged.

- Raymond's Newsletter. Brown-paper shopping bags are printed with news and as a pre-paid envelope. Information about children's disabilities and family issues are thus discretely distributed for private consumption.



If non-design, then what?

Positioned in opposition to design, what do such 'non'-design approaches negate? Certainly they challenged established practice for failure to deliver on (perhaps impossible) ideals. For example, Non-Plan objected to the imposition of civic order through policies such as those promoted by CIAM, which also appeared to be increasingly ineffectual in dealing with complex urban conditions and rapid social change. In addition, such approaches questioned ideological bases and instruments for achieving 'progress'. As previous ideological alternatives were subsumed within global capitalism, Superstudio proposed a 'life without objects' if design should merely codify power or serve the societal status quo. Questioning ideological foundations of architecture since the Renaissance, Eisenman tries to isolate some set of essential spatial relations apart from external ideological trappings. Rejecting nostalgic, utopic, or authoritarian bases, the proponents of these approaches also rejected the implicit view of society underlying such ideologies – that of an omnipresent, deep-seated cultural order and social stability.

Renounced alongside CIAM's tidy categories of 'work-leisure-home-transportation' were its generic notions of 'Modern Man' and 'humanity', neatly reducible to rational family-sized and individual units. Instead, traces of the irrational, poetry, and protest are exposed and celebrated. Agrest suggests non-design qualities of the delirious and carnivalesque. Superstudio posits design within a 'super code of conduct' and use as a 'lifelong be-in', proposing 'total involvement' in empowered interpretation and action. Unlike typically ordered and unpopulated architectural representations, Archigram's drawings were playful, psychedelic, even sinful, overflowing with slogans and billboards, women, children, wrestlers, postmen, jazz musicians, and crowds, even sea-farmers and superheroes. Not only do they ask, "Did the building satisfy the user's or the client's needs?" but "Did the client even know what his needs would be in this new world that seemed about to explode?" [47]

These were not views of society based on revolution or anarchy, but on everyday life and popular culture. While Superstudio resisted confinement to consumerist and capitalist systems, Archigram embraced consumer culture, celebrating the extremes of the free market and cyberscience in lieu of previous wartime restrictions. Forcing people to reinvent from scratch, Non-Plan was premised on the idea that alternative forms would arise that were more in tune with reality (regardless of their desirability) since they would be directly produced by market forces and consumer democracy. Blatantly celebrating American suburbia and speculative development, proposals were accompanied by tongue-in-cheek travelogues for future tourists. While denying any underlying universal order, 1960s countermovements nonetheless seemed to take an optimistic view of society, believing that alternatives to humanistic stability or socialist collectivity would be action, invention, and critical reflection.

The critique posed by non-design is not of design or planning as such, but of design in instilling and enforcing ideology. Superstudio refused design 'in service' to any imperialist ideology, whether political, technological, or cultural. Accepting that built forms embody and engender societal forms, whether imposed from the top down or generated from the bottom up, Non-Plan simply displaced responsibility from design onto the people. Eisenman also draws a more definite boundary around architecture, returning to essential spatial relations to explore ideas "unavailable to our consciousness because they are obscured by cultural preconceptions." [48] He refutes architecture's relation to any ideology outside itself, since origins and determinants outside reduce design to an 'effect' of other, external causes. Non-design may critique social, economic, and political systems – but the main concern is how design relates to such systems and to the extension of such systems into the everyday.

Unfinished forms

In testing and contesting disciplinary boundaries and responsibility, non-design proponents make use of architectural objects and methods. Rather than refusing to design or 'waiting for the revolution', proponents accepted the powerful effects of architectural representations and objects, making use of these to launch their critique from within the conventions of practice. The 'products' of non-design were not intended, however, as finished or closed forms. While object-oriented in representational or built form, non-design projects employed form provisionally, to open up ideas and alternatives in use and in wider ideological consumption.

Non-design proponents made use of existing modes of construction and production, as well as developing alternative ones. Existing implementations of CIAM's principles on a mass scale exposed their weakness better than any theoretical debate, providing a concrete basis for Non-Plan actions. Engaging with traditional manufacturing, Superstudio produced objects not just for conceptual consumption but also for wider distribution and for sale. House VI's radical structural logics – which, among other effects, divided the marital bed with a column – continue to provoke not only inhabitants but a wider audience of critics. Extending the production of architecture into alternative formats, 'paper' projects of Superstudio, Non-Plan, and Archigram took form only in publications. In such formats, theoretical, aesthetic and cultural conventions were fused – traditional representational techniques were mixed with those from pop art, tabloids, and advertising. Non-design engaged traditional and alternative modes of production to expose problems of convention and design effects.

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Non-Plans, ambiguous objects, and 'cardboard architecture' situate design forms (or absence thereof) in order to open up ideas and alternatives in use. Irrationally overloading objects with significance or emptying them of familiar associations, Superstudio's objects require interpretation and appropriation in use – thus conceived, use becomes a form of artistic happening or activism. As a material diagram of spatial relations, House VI "is not an object in the traditional sense – that is the end result of a process – but more accurately a record of a process." [49] Deliberately disturbing perceptual and practical activity, it continually forces conceptual rather than conventional forms of inhabitation – in idea and in fact, its forms "become more intrusive after they are understood: not less, but more insupportable," Robert Gutman notes. [50] The effects of absent, ambiguous, or disturbing forms do not go unnoticed, producing neither normalization nor distraction. Such forms require active and ongoing engagement – even protest or change – in use.

Non-design proponents thus explore 'open-ends' in and through design practice. Taking this to the limit, Eisenman substitutes 'products' with 'processes' in theory and practice. Having established the myth of origins in architecture, he states, "But if the beginning is in fact arbitrary, there can be no direction toward closure or end, because the motivation for change of state (that is, the inherent instability of the beginning) can never lead to a state of no change (that is, an end). Thus, in their freedom from the universal values of both historic origin and directional process, motivations can lead to ends different from those of the previous value-laden end." [51] Arguing that there is no origins, end, or direction, Eisenman refutes determinism, arriving at a self-proclaimed non-dialectical, non-directional, non-goal-oriented, open-ended tactic rather than a goal-oriented strategy. In such a view, making – whether theorizing, drawing, or building – as interwoven process/product never comes to a resolution or closure, only ever circling around itself.

'End of the end'

While acknowledging the power of design in shaping society, these examples of non-design challenged the systems and ideologies on behalf of which such power might be extended. They refused to accept a merely service role for design or purely instrumental value for design objects. Instead, they engaged in design activity and solicited design form to effect a critique from within design and in use.

Characterized by attitudes of 'reform' and 'contestation', non-design proponents reconsidered the design object. Ambasz elaborated on the attitude of 'reform', of designers "torn by the dilemma of having been trained as creators of objects, yet unable to control the significance of the uses of these objects." Refusing to "invent substantially new forms, instead they engage in a rhetorical operation of redesigning conventional objects with new ironic, and sometimes self-deprecatory sociocultural and aesthetic references." Such currents might be traced in Non-Plan and Archigram's ironic and sometimes ambivalent ideas. One aspect of 'contestation' that Ambasz outlined included designers making objects as forms of 'active critical participation.' While recognizing the 'aesthetic of the uses made of their objects', contestational designers reconsidered relations between design and use, wherein the "object is no longer conceived as an isolated entity, sufficient unto itself, but rather an integral part of the larger natural and sociocultural environment." [52]

Thus, non-design proponents designed even as they questioned the extent of their role or responsibility in determining use. Superstudio under- or over-designed artifacts to provoke interpretation. Eisenman's architecture intruded into domestic ideals, forcing recognition of cultural expectations long since naturalized into cognition and habit. Non-Plan promoted removing rather than making plans, noting, "Positive planning is all too often a disaster. For a start, it is usually based on incorrect forecasts about the future. No one is clever enough to know, in advance, how cities will grow. You cannot tell which innovation will germinate and multiply a thousandfold… Nor can we tell how people will decide to organize their lives, or how their tastes in patterns of living will develop. A city is not a computer program. It has a life of its own." [53]

These notions of non-design attempted to come to terms with competing notions of progress – economic, social, and technological – that design was meant to provide or, in more cynical terms, to promote. Dependent on flows of capital and technique, designers examined their role in serving and extending implicit logics and ideologies to users. The intersection of determining forces were inevitably complex and contradictory: capitalism seemed to promise a democracy of choice but was also the only system in the West and therefore totalitarian; contemporary cybernetic theories promised alternatives to static traditions but also seemed to extend modernist technological determinism. Provoking a reconsideration of ideology and responsibility, such approaches sought to establish bases for critique within design and within the rapidly shifting conditions of wider socio-economic systems.

Outside and after design

Examining technology and design from the perspective of critical theory and STS, it might be easy to conclude 'it's all politics'. Certainly, such perspectives excavate the ideologies and power relations within the realm of human activity and material culture, including its artifactual production. To the extent that design extends the ideas of its makers and ideals of its commissioners into use, it is engaged in a sort of 'ideological transfer'. Even when pursued as mere 'tech transfer', the design of technological objects must engage in a realm of ideas about design and use, as well as applying materials that in themselves are far from neutral. Indeed, certain technologies have been explicitly developed in such terms – for example, as discussed in 'Participatory practice', values of decentralization, openness, anticommercialism and anti-authoritarianism designed into the architecture of the Internet. [54]

Delving into such perspectives does not simplify our understandings of the relations involved – in fact, they reveal inherent and evolving complexity. Just as a platform such as the Internet might be developed according to certain ideologies, it is available to users by means of a range of other hardware devices, software programs, and service providers with perhaps quite different ideological motivations, even subject to 'internet governance'. Just as 'design' does not involve any absolute determination or unequivocal translation of ideas into form, nor does 'use' merely involve efficient translation of and compliance to such ideas. Between design and use, a range of complex factors comes into play. An artifact is neither wholly political nor entirely neutral, 'a pliable and diligent slave' to any one ideology or its absence. As Latour puts it, "whenever we talk of matter we are really considering, as I am trying to show here, a package of former crossovers between social and natural elements, so that what we take to be primitive and pure terms are belated and mixed ones." [55]

It becomes not so much whether or even how power and ideology, society and nature, are intertwined. Once we understand that such systemic forces are inevitably involved – and before we get to the point of looking more specifically at how – we have to consider how to orient ourselves in relation to such notions. Under a banner of 'it's all politics', there is even less potential than decades ago in withdrawing and 'waiting for the revolution'. Even adhering to phenomenological accounts, such as those discussed in 'Use', we must not obscure the need for developing critical positions to understand and operate, both as designers and as users. Indeed, understanding that power relations are inscribed on our spaces and bodies, our time and everyday practices, even in not taking a stand we are still somehow enacting, and thus perpetuating, 'scripts'.

If design is taken to be 'in service' or 'as application' of other determining systems, then use becomes merely third-order compliancy, and users merely as 'caricatures' enacting scripts. As Anthony Dunne articulates:

> This enslavement is not, strictly speaking, to machines, nor to the people who build and own them, but to the conceptual models, values, and systems of thought the machines embody. User-friendliness helps to naturalise electronic objects and the values they embody. For example, while using electronic objects the use is constrained by the simple generalised model of a user these objects are designed around: the more time we spend using them the more time we spend as a caricature. [56]

The perspectives discussed above with respect to non-design reveal the difficulties of orientation within design practice. Non-design proponents operate at the edge of

what might be considered acceptable practice. However, even at the fringes, there is the basic dilemma that the ideological autonomy possible in other fields is simply impossible to sustain in design. Technology, culture, society, and economy are inevitably involved in production, distribution, and use, even if designers attempt some sort of autonomy. Thus, non-design proponents worked in relation, even if in opposition, to design. For example, proponents of anti-design developed alternatives to traditional production, and Eisenman developed a complicitous relationship with his client even while retreating into formal autonomy. While design may not operate in transparent service to users or clients, nor as a simple instrument of ideology, neither can it be merely 'art for art's sake'. There can be no 'total design' since neither design nor use may be conceived completely, as a design ideal or as a future reality – nor should it be according to non-design.

The question, thus, becomes how to position a critique within such a complex picture of reality. Even as we might be wary of 'totalizing' interpretations, perspectives from critical theory and STS might overwhelm us with a picture of total relativity. Without the clear-cut dialectics of past theory and politics, it seems even more difficult to locate a basis for posing and sustaining a critique at any significant scale. This is precisely the question that Diana Agrest addressed. Setting out the notion of non-design, she extended the concept of overdetermination (originally from Freud and extended by Althusser) to challenge simplistic notions of determinism and establish grounds for critical enquiry. Along such lines, she argues that no practice (design, for example) can ever be completely determined by another (say, economy or politics), nor can it be entirely autonomous. Instead, each is determined by the effects of all the others simultaneously.

Thus, she opposes 'design' with 'non-design', not as discrete categories but as provisional frames for identifying general particularities and overlaps. Where design can be seen as a normative system, with a historically determined subject and a body of written theory as a basis for producing and fixing meaning internally, non-design might be said to have no established rhetorical system nor a unique producer or subject. Non-design encompasses the aspects of culture that fall outside or in-between distinct systems, describing a distinct but broad territory of occupation, production, and use. Thus, irrational, unconscious, poetic, and unpredictable phenomena may be recognized by design without conforming to or being subsumed within its norms. Arguing that a critique of any single cultural system can only be valid as it is related to an alternative, she positions the need for an 'outside' to design, one explicitly and necessarily beyond its purview.

With respect to developing a critical position in design, perhaps the central issue is how to move from philosophy and analysis – modes of operation central to critical theory and STS – to modes of operation in design. Certainly, Agrest's position might be further reviewed since the basic structuralist terms have been the subject of much debate since. However, she sets out various theoretical frames that, within architecture, have been taken up within a larger and vivid critical discourse. This discourse, thus, sets out some issues for a notion of 'Critical practice' in the next section.

Futurity

Besides an 'outside' to design posed in systemic terms, we might also propose one in temporal terms. Indeed, if there is anything beyond the scope of the design act and imagination, it is 'futurity'. Elizabeth Grosz notes that it is the impulse of power to determine and secure the future in face of its inherent openness. She argues, "The extent to which one remains committed to determinism is precisely the degree to which one refuses the open-endedness of the future. In seeking an open-ended

future, one is not required to affirm the misnomer, 'free will', but to acknowledge the capacity of any future eruption, any event, any reading, to rewrite, resignify, reframe the present, to accept the role that the accidental, chance or the undetermined place in the unfolding of time." [57] We cannot hope to determine the future entirely – indeed, the future will reframe our present just as we historicize the past today.

Grosz proposes an understanding of "time as an open-ended and fundamentally active force – a materializing if not material – force whose movements and operations have an inherent element of surprise, unpredictability, or newness." [58] Future concepts such as 'newness', 'innovation', and 'progress' are central to the rhetoric of design and technology development, as they are to politics. However, counterparts of 'unpredictability', 'disorder', and 'indeterminacy' seem to be less welcome. There is, of course, a range of attempts to explain, contain, organize, and categorize unexpected events or future eventualities – design and politics are similarly engaged in analysis, prediction, and projection to various degrees. Each are concerned with planning and preparing for 'what might be', even 'what should be'.

Although it is part of design to prepare for the future use it anticipates, projection and planning in design should not be confused with that in politics, which are always indeterminable in their application. Design might aim not just to end in things that produce the anticipated, but, as taken into use, produce the unexpected. Indeed, inevitably, designs are not merely used or misused, but incorporated, reinterpreted, appropriated, and even reconfigured. The design of specific interactions with technological objects produces particular cognitive, phenomenological, and ideological effects. We cannot ever hope to completely secure or fully determine future use – just as politics can never hope to settle any 'final solution' or set of ideal interactions within society. Design can only ever propose highly provisional and competing ideas with respect to the problem of how to live and relate to others. It is a question of space, but also negotiated over time.

Design is inevitably engaged in ideology, persuasion, and change. However, rather than retreating into autonomy, utopia, or 'total design', perhaps we might pursue and expose open ends in form and in time. Design is also about deciding what not to design – what to leave open to use or to the future. To explore the implications of such a proposition – the limits and responsibilities, as well as the power, of design – requires developing a critical discourse and critical modes of operating as designers. To develop a critique from within the practices and products of design entails an inevitably compromised position, more similar to reform and contestation than revolution. However, it is through examining practices – of design and of use – that we might hope to develop forms of 'active critical participation' that provoke reflection and evade normalization.

Notes

1 See Philips Design, *Vision of the Future*; Mau and Leonard, *Massive Change.*

2 See Connerton, *How Societies Remember*.

3 See Margolin, "Expanding the Boundaries of Design," in *Idea of Design*, ed. Margolin and Buchanan; Winner, "Political Ergonomics," in *Discovering Design*, ed. Buchanan and Margolin; Baudrillard, *System of Objects;* Baudrillard, "The System of Objects," in *Design after Modernism*, ed. Thackara.

4 For related discussions see Redström, "Persuasive Design," *Proceedings of PERSUASIVE*; Buchanan, "Declaration by Design: Rhetoric, Argument," in *Design Discourse*, ed. Margolin; Fogg, "Persuasive Computers," *Proceedings of CHI*.

5 Buchanan, "Declaration," 93.

6 Buchanan, "Declaration," 94.

7 McLeod, "Architecture and Politics" (*Assemblage,* 1989), reprinted in *Architecture/Theory/since 1968*, ed. Hays, 682.

8 Dovey, *Framing Places*, 184. See also, Dovey, "Place / Power," *Architectural Design*; Hillier, *Space is the Machine*; Foucault, *Power/Knowledge*.

9 See Virilio, *Aesthetics of Disappearance*; Foucault, *History of Sexuality.*

10 Silbey and Cavicchi, "The Common Place of Law," in *Making things Public*, ed. Latour and Weibel, 561.

11 See Von Hippel, *Democratizing Innovation*.

12 Foucault, *History*, 244.

13 Winner, "Political," 147.

14 See Bijker, *Of Bicycles, Bakelites, and Bulbs*; Bijker and Law, eds., *Shaping Technology / Building Society.*

15 Latour, *Pandora's Hope*, 190.

16 Latour, *Pandora's*, 189.

17 Latour, *Pandora's*, 186.

18 Akrich, "The De-Scription of Technological Objects," in *Shaping Technology/ Building Society*, ed. Bijker and Law, 208, 223.

19 Akrich, "De-Scription," 214, 208.

20 Winner, "Technologies as Forms of Life," *Whale and the Reactor*, 11.

21 Winner, "Political," 147.

22 Picon, "Architecture and the Virtual," *Praxis*, 115.

23 See Redström, "Towards User Design?" *Design Studies*.

24 Margolin, "Expanding," 279-280.

25 For related arguments see Attfield, "Dangers of Good Design," in *Utility Reassessed*, ed. Attfield; Grosz, *Architecture from the Outside;* Jameson, *Archaeologies of the Future*.

26 See, for example, Conrads, ed., *Programs and Manifestos on 20th-Century Architecture*.

27 Shedroff, *Experience Design*, 96, 284. See also Laurel, *Computers as Theater*; Fogg, "Persuasive."

28 Shedroff, *Experience*, 2

29 Wigley, "Whatever Happened to Total Design?," *Harvard Design Magazine*, 24.

30 See Agrest, "Design Versus Non-Design," *Oppositions*.

31 Ambasz, ed., *Italy: The New Domestic Landscape*, overleaf.

32 Adolfo Natalini (1967), quoted in Lang and Menking, *Superstudio: Life without Objects*, 15. See also, Kristofferson, "Memphis och den Italienska Antidesignrorelse" (PhD diss.).

33 Archizoom and Superstudio, "Destruction, Metamorphosis and Reconstruction" (*In*, no. 2-3, 1971), reprinted in Lang and Menking, *Superstudio*, 120.

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34 Adolfo Natalini (lecture, Architecture Association, 1971), quoted in Lang and Menking, *Superstudio*, 20-21.

35 Superstudio, quoted in Lang and Menking, *Superstudio*, 117.

36 Archizoom and Superstudio, "Destruction," 121.

37 Frampton, *Modern Architecture*, 288.

38 Sadler, "Open Ends," in *Non-Plan*, ed. Hughes and Sadler, 138.

39 Banham, Barker, Hall, and Price, "Non-Plan: An Experiment in Freedom," *New Society*, 438. For a contemporaneous approach see the discussion in the section 'Becoming users' on 'vernacular architecture', and; Venturi, Scott Brown, and Izenour, *Learning from Las Vegas*.

40 Webb, "Boys at Heart," in *Archigram*, ed. Cook, 2.

41 Eisenman, "The End of the Classical," *Perspecta*, 531.

42 Eisenman, Gass, and Gutman, "House VI," in Frank, *Peter Eisenman's House VI*, 21. For a discussion of 'type' and typology, refer to the section 'vernacular architecture' in 'Becoming users'.

43 Eisenman, Gass, and Gutman, "House VI," 22.

44 Eisenman, quoted in Kimball, *Tenured Radicals*, 124-5.

45 Eisenman, quoted in Kimball, *Radicals*, 125. See also, Hays, "The Oppositions of Autonomy and History," *Oppositions*.

46 Eisenman, "Notes on Conceptual Architecture," *Design Quarterly*, 2.

47 Webb, "Boys," 3.

48 Eisenman, Gass, and Gutman, "House VI," 23.

49 Eisenman, Gass, and Gutman, "House VI," 23.

50 Eisenman, Gass, and Gutman, "House VI," 33.

51 Eisenman, "End," 532.

52 Ambasz, *Italy*, 19, 19, 20.

53 Barker, "Non-Plan Revisited," *Journal of Design History*, 108.

54 See Galloway, *Protocol: How Control Exists after Decentralization*.

55 Latour, *Pandora's*, 205.

56 Dunne, *Hertzian Tales: Electronic Products*, 30.

57 Grosz, "Thinking the New," in *Becomings*, ed. Grosz, 18.

58 Grosz, "Becoming... An Introduction," in *Becomings*, ed. Grosz, 4.

* For more information on 'Mixers' see Mazé and Bueno, "Mixers: A Participatory Approach," *Proceedings of DIS*.

Critical practice

Design is about transformation – of raw materials into useful things, of competing ideas into persuasive forms, of present situations into future reality. As discussed in the previous section on 'Design effects', design involves moving from understanding of 'what is' to inscribing 'what might be'. Designers propose probable solutions and possible futures, transforming ideas into form. Inevitably ideological, design activity is also inextricable from systems of production and consumption. Just as it is socially constructed, design activity extends ideology and even moral authority into the realm of use. Inscribed with certain ideas and possibilities, design products, in turn, prescribe certain ways of acting and interacting in use. Objects enable and disable activities and behaviors, circumscribing everyday practices. As it produces form, design also produces social, cultural, and political effects.

Enquiring into the agency of design reveals not just its power to effect change, but also a certain uncertainty or indeterminism. On one hand, though design cannot be about 'matters of fact' – since there are neither final nor absolute answers to design problems – its products nonetheless become naturalized into our ways of thinking and acting. In use, we may forget the reasoning behind our choice to behave in certain ways – for example, only by crossing borders may we discover 'breakdowns' in our habitual actions or cultural norms. Technological artifacts, in particular, are not only incorporated into public and private spaces, they occupy our time. Considering that all objects to some extent prescribe how they might be used, interaction involves 'scripts' played out over time, as designed patterns of behavior become intimately interwoven into everyday practices.

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While recognizing this power of design, we must, on the other hand, consider a variety of additional factors and relations in everyday life and social lifeworlds. Just as design is not an exact science, neither does use merely involve efficient translation of ideas. An interpenetration of technical, human, and cultural factors blurs distinctions between cause and effect, even between design and use. Any 'prescription' by design is negotiated in subsequent practices and cultures of use, as intended meanings and functional possibilities may be refused or incorporated, deliberated or reappropriated. The consequences of design lie in use and in the future – but future use is amenable neither to complete determination nor precise prediction. Complicating simplistic notions of determinism reveals the utopianism of any 'total design', as is any final solution to questions of human relations.

Since the consequences of design lie in the future, its impact reaches far beyond accommodation of immediate needs or solutions to present-day problems. Technological objects, in particular, involve temporal form and the form of interaction that unfold in use and over time. Thus, interaction design involves a particular concern for the power of design and questions of determinism with respect to future use. Unknown factors about potential users and unpredictability of future use may be handled in various ways – for example, in terms of social science studies, participatory or user centered design, and iterative product development. Contrasting 'total design' with the challenges raised by 'non-design', we might also seek ways of engaging with design effects by thinking and working critically from within – and by means of – interaction design.

Thus summing up the previous section, some issues might be opened as a basis for considering design effects and 'Change' in practice. Design carries not only the possibility but the responsibility of exposing choices, alternatives, and consequences. As Andrew Blauvelt articulates, "Design's task is to make us more aware of its effects, reconciling the growing predictability of design's conspicuousness – the

familiarity of the strange – by disrupting its inevitable absorption into the everyday – the strangeness of the everyday." [1] If we – designers and users – are not mere products of a situation but active in creating and changing it, we must find ways of opening up for reflection, enquiry, and debate. In interaction design, in particular, we must consider our role and responsibility towards design effects and future use, since we are predetermining it to a much greater extent.

The following section on 'Critical practice' examines such issues and a range of possible approaches. While there is a long-established discourse about criticality in architectural theory and practice, such ideas are only starting to impact the relatively new field of interaction design. Looking to architecture, as well as tracing 'conceptual', 'concept', and 'critical' tendencies in product design, this section attempts to map out a landscape to locate a (or – perhaps preferably – more than one) 'critical practice' in interaction design.

In order to extend concerns about 'Design effects' into a notion of 'Critical practice', certain issues are drawn out to synthesize main points discussed in the previous sections, with pointers to implications for practice, as follows:

Systems
Products of multiple determining forces, technological objects embody and transfer the ideological conditions of design into use. In practice, this entails a concern not only for proximate use but also for issues of agency in systemic change.

Alternatives
Design objects enable and disable possibilities in use – the form of interaction with technological objects, in particular, is embedded in everyday and cultural practices. For interaction design, this entails a concern for how design intent is engaged in use.

Operation
Between design and use, design objects are produced in ways that affect perception and effects. As a multi-disciplinary practice, interaction design must locate particular concerns in relation to diverse disciplinary and institutional frames.

Critical traditions

Design is located in an ambivalent place, wavering between the concerns of culture and capital, which may be more decisively dealt with in art, craft, or architecture. Art and architecture have long-established traditions of criticism – art can even take on the role of reflecting and criticizing society. In each, criticism is not so much a matter of evaluation, of measuring or quantifying value, but of qualification within larger historical, philosophical, and disciplinary frames. Within architecture, criticality itself has long been the subject of vivid debate, within discourse and in practice. In the 1960s, distinctions were made among architectural history and theory, 'operative critique' – and 'criticism from within' practice. In art and architecture, there are thus rather established foundations for locating respective concerns and forms of critique.

The basis for criticality in design as a whole is less definitive. In architecture, disciplinary concern, for aesthetic or social theories, for example, might be distinguished from those of the profession, which regulates the accommodation of basic utilities and functions, or from those of other domains, such as real estate, public opinion, or popular culture. Within the applied arts as a whole, various types of design have emerged more recently, and thus disciplinary and professional terms of practice are less distinct. As Anthony Dunne observes, "whereas architecture and fine art often refer to popular culture, industrial design is popular culture." [2] Indeed, such terms of practice may be so bound up in the specific economic or technical conditions of its emergence, for example during the Industrial Revolution, that it is difficult to locate a basis for challenge or change. This prompts John Thackara to argue, "Because product design is thoroughly integrated in capitalist production, it is bereft of an independent critical tradition on which to base an alternative." [3]

One alternative would be to locate outside of, or in opposition to, the terms set by capital or production. Crafts, for example, are typically maker-led and hand-made, rather than reliant upon mass production or mass-markets. This might also be seen in ideological terms, as art historian Helen Rees reflects:

> It is easy to overlook the arguments presented by design, because they constitute the mainstream and represent the dominant mode of production. Only at the edges (of fashion, price or taste) does a design 'statement' become impossible to ignore. On the other hand, all craft represents a counter-culture, and thus the production or purchase of a craft object is a form of dissent. The choice of a craft object is always self-conscious. [4]

There are, however, alternative perspectives within design that diversify or counter mainstream views on what design should be about. While rather amorphous as areas of interest or communities of practice, such tendencies are amassing an increasing number of examples, theoretical depth, and public exposure. [5]

In such views, design, amended as 'conceptual', 'concept', or 'critical', may counter conventions of utility and efficiency, profit and taste. This is not without precedents – indeed, influences may be traced via Dada and Surrealism in conceptual art and the 'new jewelry' and 'new ceramics' in radical craft, which fueled anti-designers in the 1960s. Often produced as one-offs destined for display, rather than for sale, the products of such design is less about 'problem-solving' than 'problem-finding' within disciplinary and societal discourse. Such tendencies expose the conditions of design – and how design conditions use – seeking to evade or challenge conventional production and consumption.

With respect to their agenda for critical design, Dunne and Fiona Raby state: "At its worst, product design simply reinforces global capitalist values. It helps to create and maintain desire for new products, ensures obsolescence, encourages dissatisfaction with what we have and merely translates brand values into objects. Design… needs to establish an intellectual stance of its own, or the design profession is destined to loose all intellectual credibility and be viewed simply as an agent of capitalism." [6] Such ideological and intellectual bases were explicitly at stake in anti-design, as the purview and products of design extended well beyond conformity and even reform. Contestation was seen as essential, as discussed in the section on 'Design effects', with a basis in direct political and philosophical action – and within design practice. Rather than design 'in service' to problems and ideologies determined in advance and outside, design form was employed to open up for 'active critical participation'.

Dunne and Raby share similar concerns, further noting, however, "But critical design must avoid the pitfalls of the 1970s by developing strategies that link it back to everyday life and fully engage the viewer. Things are far more complex today than they were 30 years ago. It is not enough to simply offer an alternative, new strategies need to be developed that are both critical and optimistic, that engage with and challenge industry's technological agenda." [7] Certainly the political basis for anti-design and related countercultures is not present within society as before – indeed, many radical elements were rapidly subsumed into the mainstream. More generally, the basis in capital, industry, and technology that underpin past conceptions of criticality – indeed, of design – no longer hold in the same way, or to the same degree. Even in architecture, recent post-critical tendencies challenge the boundaries distinguishing different areas of concern. Such complexity within and surrounding contemporary design make it difficult to locate the terms of criticality.

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Critical practice
Critical traditions

With a technological shift from mechanical to current post-industrial paradigms, there have been various attempts within technical practice to develop critical terms. For example, 'critical computing' is the topic of a small decennial conference exploring issues of society, democracy, and ethics in systems development since 1975. The goals of this community in 'taking critical action' have been, as Christiane Floyd notes, rather effectively integrated into development methods and processes, for example in Participatory Design, and in reframing certain disciplines, such as informatics. Also informed by the social sciences, Phil Agre applies critical theory for analyzing historical and operational frameworks in his field of artificial intelligence. Related notions of 'critical technical practice' have also been explored by Krzysztof Wodiczko, Chris Csziksentmihalyi, and Natalie Jeremijenko in relation to media art. These approaches reflect upon and question conventions by drawing intellectual concepts from critical political and social theories into practice. [8]

While not explicitly treating notions of criticality, several recent approaches in HCI and interaction design have argued for increased reflection in practice. For example, Donald Schön's notion of the 'reflective practitioner' resonates in calls for 'thoughtful interaction design' and 'reflective design'. Jonas Löwgren and Erik Stolterman argue for developing thoughtfulness about personal design ability as a question of "assuming responsibility for one's own professional mind." Phoebe Sengers and her colleagues develop a concerted argument for reflection as a means for both designers and users to rethink dominant metaphors and values in HCI. Shifting perspective from 'reflective design' to 'designing for reflection', Lars Hällnas, Johan Redström, and colleagues have developed certain foundations for exposing design issues in the 'aesthetics of use'. Such approaches indicate increasing commitment to reflection – within design practice, upon design effects, and in use. [9]

A notion of 'critical practice' poses particular challenges to interaction design, as a relatively new and multi-disciplinary field. For one thing, developing an 'intellectual stance' requires consideration of the appropriate incorporation of critical social theory and critical social science. Certainly ideological reflexivity about the social construction of knowledge, methods, and practice has begun to inflect interaction design by way of critical technical practices. However, the challenge is not only to understand and incorporate 'critical theories' from without, but to understand the unique potentials and problems of 'criticism from within' practice. However, the disciplinary terms in which the 'insides' might be distinguished from the 'outsides' of interaction design are not self-evident.

In order to further ground a discussion in relation to theories and practices of design, the applied arts and architecture offer an established discourse and diverse examples of criticality in action. As a basis for approaching a notion of 'critical practice' in interaction design, this section surveys the development – and contemporary revision – of certain ideas with respect to 'criticism from within' design.

For example, the emergence of post-critical perspectives in architecture and alternative tendencies within product design exposes issues with respect to criticality. 'Conceptual design' draws on conceptual art and anti-design to orient a subversion of design norms, intervening in concepts and behaviors engaged in use. 'Critical design' focuses on the social, cultural, and ethical implications of design objects and practice. Through materiality and aesthetics, these approaches shift attention away from the spatial object in and of itself to the ideas behind the object and engagement with such ideas in use over time. 'Concept design' explicitly treats the extrapolation from the present into scenarios of future possibilities and problems. Located within existing systems of capital and culture, these approaches challenge the terms and modes of production, as well as the ideas and agency involved in consumption – and how these are mediated by design materials and form.

Further, while drawing upon theories and practices of criticality within various related disciplines, interaction design explicitly deals with the combination of technical and design concerns. Rather than merely affirming or acquiescing to 'industry's technological agenda', critical practice in interaction design must contest the terms on which technology and design are related. That is, we must not only deepen understanding of existing approaches within various related domains, but we must examine how these complement or conflict with one another with respect to the particular concerns of interaction design.

For example, we must gain a better understanding of the role of temporal, as well as spatial, form in setting the terms for engagement with such ideas in use. Certainly 'conceptual', 'critical', and 'concept' design touch upon temporality with respect to the reflective consumption of ideas, alternative performances and behaviors, and future projection. Further, we must deepen our understanding of interaction design in opening up for 'active critical participation' in cultural and societal change. More precisely, we might speculate on criticality with respect to concepts of 'technology as material', 'temporal form', and 'use as participation' explored extensively in this text. Such concepts might anchor additional questions and possibilities, which might frame lines of enquiry specific to critical practice in interaction design.

(Post-)Criticality

In order to position a critique within design, or of other domains by means of design, a certain basis for exchange of ideas must be established. For example, in architecture, client relations and legal norms may be taken up within the terms of the profession, aesthetic concepts and social theories within disciplinary discourse. Thus, operational and intellectual terms are continually negotiated, such that theories and influences from other domains are interpreted critically with respect to the particular concerns of architecture. Such terms have been central to criticality in architecture, as revised in the 1960s and 70s, and as today under revision in the 'post-critical' turn. This discourse has created a vivid space for theoretical and practical speculation over the last decades, producing a number of approaches that anchor more general issues with respect to a notion of critical practice. [10]

In intellectual terms, critical discourse in architecture has been an arena for developing relations to theory. More precisely, 'Critical Theory', posed by the Frankfurt School in the early 20th century, and 'critical theories', as more generally referred to since French post-structuralist thinking, have posed a series of concepts that have been explored in architecture. This ranges from ideas of materialism, existentialism, and phenomenology (referring to, for example, Benjamin, Habermas, Lefebvre, and de Certeau) and social and epistemological conditions (drawing on the thinking, for example, of Foucault, Derrida, Althusser, Deleuze and Guattari). In the 1970s, with the end of an 'era of manifestos' (generally characterized by a few polemic positions and loose relations between theoretical rhetoric and practical reality), there was a general reconsideration of how to relate to theory in architecture. This involved rethinking 'operative criticism', posed from inevitably biased positions within practice, and 'critical theories', introduced from without.

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Critical practice
Critical traditions

With respect to these 'border issues' in discourse, several positions were staked out. Diana Agrest's 'non-design', for example, argued for a semi-autonomous architecture, in which certain aspects were understood as particular and normative but those shared with other modes of production could be the basis for valid critical discourse. Historian Manfredo Tafuri argued that although political and practical terms might coexist, for instance within an individual practitioner, real ideological alternatives could not exist within a hegemonic system – thus, a truly critical architecture could only follow systemic transformation. As Frederic Jameson reflected later, the crisis in the 1960s and 70s "tends to be accompanied by a mood of pessimism and hopelessness that must naturally enough accompany the sense of a total system, with nothing outside itself, within which local revolts and resistances come to be seen, not as the emergence of new forces and a new logic of a radically different future, but rather as mere inversions within the system, punctual reversals of this or that systemic feature – no longer dialectical in their force, but merely structural(ist)." [11]

Others argued against 'waiting for the revolution' – Jorge Silvetti took up the debate within Agrest and Tafuri's structuralist terms, but sought the possibility of 'criticism from within'. [12] He posits that making, while necessarily compromised, gives form to critical issues that might otherwise be obscured by language or ideology. Like Tafuri (following Foucault), he differentiates 'commentary' from 'criticism', acknowledging that architecture inevitably relates to conventions and is thus bound to hegemonic ideological systems. However, he argues that such relations may exceed mere quotation or commentary to leverage a critique through transformations possible only through architectural practice and form. In taking form, though, the critical power of objects can only ever be provisional and short-lived, inevitably subsumed as their impact is absorbed into larger systems of cultural consumption and theoretical knowledge. Recognizing this is not to dismiss the importance of a critical architecture,

rather of clarifying its role, which goes beyond that of rhetoric precisely through material and behavioral transformation.

By the 1990s, positions with respect to 'critical architecture' had polarized into two camps, as Michael Hays outlines, one concerned with culture and the other preoccupied by form. In the first, architecture is seen as an instrument of culture, whether in historical or popular terms. The architect becomes a sort of interpreter, with a perspective that is analytic and retrospective, at worst merely ennobling cultural values and perpetuating hegemonies. In the second view, architecture is explored as an autonomous and self-referential system of formal knowledge. The architect, in explicitly rejecting any single, external, or historical truth, becomes entirely concerned with the forms of architecture, conceived as a sort of "ideal moment in a purely conceptual space." [13] Where the cultural perspective is preoccupied with efficient representation and a conciliatory relation to external forces, the formal perspective is disengaged from the contingencies of time, place, and use. Where the first view looks backwards to history and outwards to culture, the second looks inwards to some ideal state – neither is world- and self-aware simultaneously (or at all).

Recently, there has been another revision to notions of criticality in architecture and a movement towards what has been called the 'post-critical'. Rather than concepts of resistance, disjuncture, and negation, post-critical proponents explore projection, performativity, and pragmatics. In such perspectives, theory and criticality are not rejected but are repositioned in relation to a constructive and projective attitude, capable both of ideological and operational engagement. In fact, the mere pairing of the terms 'critical' and 'practice' becomes possible where previously, as Mark Jarzombek points out, it might have been a general cover for 'anti-theory'. Stan Allen, who is associated with the post-critical turn, states: "Theoretical reflection should provoke doubt, not referee uncertainty. The exercise of theory solicits practice as a way of constructing doubt." [14] Practice is explicitly put forward as an approach to – through construction – framing questions and alternatives to the status quo in the public realm, in use, and over time.

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Critical practice
Critical traditions

While the post-critical discourse is relatively new and fragmentary, certain positions indicate potential directions in the discourse. For one, a pragmatic turn situates critical engagement in relation to material form and modes of operation. Rem Koolhaas reflects, "Maybe some of our most interesting engagements are uncritical, emphatic engagements, which deal with the sometimes insane difficulty of an architectural project to deal with the incredible accumulation of economic, cultural, political but also logistical issues." [15] Indeed, procedural issues such as zoning involve legal, political, and economic factors, and are thus often perceived to be outside the scope of design. Not engaging with these, however, has the end result of reinforcing rather than challenging or transforming the status quo. In post-critical accounts, logistics and procedures come into focus as an arena for criticism and change.

Various positions within this discourse around criticality are also evident in form. Often taken to epitomize 'critical architecture', Peter Eisenman's 'difficult form' impedes unthinking incorporation. By systematically inverting conventional visual and spatial relationships, for example in House VI, he effects a disruption of perceptual and domestic norms. By such means, inhabitants might be provoked out of ordinary sense perception into a conceptual attitude, to consciously 'read' space. In contrast, Elizabeth Diller argues "a resistant architecture need not rely on the erasure of familiarity." [16] The work of Diller + Scofidio does not overtly negate or even invert norms, constructing a more subtle interplay of socio-spatial factors. The construction of power, gender, or class is exposed and amplified in an almost forensic manner,

insinuating doubt and new questions. As a sort of 'embodied conceptual art', inhabitation involves not just reading and reflecting, but performing and imagining.

In recent accounts of criticality in architecture, practice is understood to involve explicit and continual choices with respect to ideas and ideals. Indeed, as an ideological and projective modality, design is inherently political. Allen states: "Hence a shift from the 'ontological' to the 'political'. By this, I mean a recognition of architecture's status as fundamentally a projective discipline. Architecture's potential lies not so much in its ability to function as a critique, to interrogate existing reality from some imaginary locus outside that reality, as in its ability to project alternative realities from an necessarily compromised position as a constituent part of that reality. Not new descriptions of existing realities (which would trust in architecture's analytical and mimetic capacity) but forceful propositions about future realities (which would foreground architecture's creative and affirmative capacities)." [17] While form occupies a powerful place, both materially and culturally, the power – and responsibility – of design is understood as constructing doubt and the possibilities for change.

'Criticism from within'

The discussion of (post-)critical architecture exposes ways that architecture negotiates relations to other domains that circumscribe its operational and intellectual conditions. While art might refer to popular culture or reflect market pressures, architecture is deeply dependent upon sources of finance and power, which thus extend into every aspect of design, from site and program to material and construction. This seems to imply the impossibility of any completely autonomous architecture, and the necessity of developing a basis for relating to and critiquing the conditions that circumscribe it. Further, architecture is not a matter of merely mimicking or reproducing that which exists already, but of actively transforming the present and, thus, determining future realities. This requires understanding architecture not only in ontological but political terms, implying the need not only for an intellectual but an ideological basis for operating.

Such bases may be present in design processes – as might be evident in post-critical concern for logistics and procedures – and in the products of architecture. Indeed, following Silvetti's argument, it is precisely the spatial and material qualities of architecture that give form to critical issues that might otherwise be obscured. Even as architecture might be dependent on larger superstructures, Giancarlo de Carlo argued, "it allows the wedging of physically perceptible and experiencable facts into the narrow margins of choice (or into the wounds opened up by contradictions) of the structure as it exists today." [18] While acknowledging an inevitable relation to previous conventions and external conditions, it also implies a unique potential for leveraging a critique from within.

Besides criticality in architecture, there is a range of parallel and growing tendencies in the applied arts. Like architecture, product design is even more embedded within and thus dependent upon systems of finance and power, for example to support mass production and distribution. Additionally, product design is typically qualified in terms of market value or return on investment. This makes challenges to conventional systems – and values – of production and consumption particularly noteworthy within a range of recent tendencies in and around product design. Without architecture's distinction between the profession and the discipline, it is a difficult matter to ground the ideas and concerns to anchor such challenges. However, this indicates certain potentials for a growing critique of design from within, a critique not only *of* design but *as* design.

A close look at certain tendencies in contemporary product design reveals a range of approaches to criticality in and through practice. For one, some are positioning design in relation to strategies and institutions perhaps more associated with conceptual art and radical crafts. Others borrow the polished representational and communication techniques from world fairs and trade expositions to provoke discussion with media, industry and the public about different futures made possible by design. And still others instigate a debate about the ethical and moral implications of emerging technologies as design mediates reception and use in consumer society.

Proponents within such tendencies certainly recognize the ideological power and effects of design, leveraging the propositional and projective potentials of material form to change behaviors and aspirations on an individual, industrial, and public basis. Rather than final solutions or end-products for mass production, design may be seen as a form of socio-aesthetic enquiry. Collectively, such tendencies are drawing an alternative territory of concerns, in which designers take responsibility for negotiating a 'criticism from within' as well as 'critical theories' introduced from without.

Some approaches

Radical tendencies in contemporary design span a range of practices in the arts and crafts, industrial and interaction design. This implicates diverse scale of production, disciplinary traditions, and conceptions of methods and making, reception and value – rendering it difficult to compare and contrast in terms of any common basis. However, sketching a diversity of concerns already expands the ways in which we might think about the form and role of 'forceful propositions' – in design and use.

With respect to the terms 'conceptual', 'concept', and 'critical', as applied to design, there is much overlap and ambiguity. [19] Here, the concern cannot be to define such terms or categorize works – this would be a difficult (and perhaps unproductive) task, since the use of such terms varies widely in the history, language, and interpretations across disciplinary and national boundaries. Hence, the terms are used here in a broad and thematic sense, drawing generally on historical or other precedents and readily acknowledging that many examples could well be described by more than one of these terms. However, some differentiation seems necessary – with the growth in related areas of interest and communities of practice, it also might help to be more precise in order to locate specific concerns and potentials.

Thus, in thematic terms, I relate 'conceptual design' to concerns in conceptual art, 'concept design' as traced from an industrial heritage of world's fairs and trade shows, and 'critical design' as generally associated in product and interaction design with Dunne & Raby. Here, such themes are used to frame alternative approaches that might anchor some orientations with respect to a notion of critical practice.

Change
Critical practice
'Criticism from within'

Conceptual design

Conceptual design draws on art to orient a subversion of design norms. Anti-design precedents in Alchemia and Superstudio drew inspiration from Dada, Surrealism, and Situationism, within a long tradition of political engagement in Italian design and a unique manufacturing environment. They created provocative one-offs for exhibition, sketches for publication, or limited production runs for sale. With respect to conceptual art, conceptual design might be described as shifting focus from the artist and the object to the concept, and making as setting up such a concept (through material things, scripted or improvised interventions, installations or other means) to challenge ideas, institutions, and audiences. As conceptual art mounted a critique of art by challenging institutional frames, for example transgressing the spatial and symbolic connotations of the gallery through readymades and intervention art, conceptual design subverts ingrained expectations of design. [20]

An interest in conceptual factors has developed strongly in crafts and product design. As Martina Margetts noted, "mantras such as the 'new ceramics' and 'new jewelry' suggest changed priorities, in which conceptual ideas flourish alongside, sometimes instead of considerations of use." [21] Since the 1990s, conceptual design has been widely associated with Droog Design, which launched in reaction to Italian radical design and the Bauhaus, dominant viewpoints in Europe at the time, and to design as a technical discipline, dominated in The Netherlands by Philips. Countering both kitsch and analytic design, Droog employs dry humor to instigate a subtle subversion of convention. A growing number of conceptual designers, architects, and craftspeople, include, in Sweden, Lagombra, Uglycute, and Front design. Even as such designers draw on artistic methods to critique design, they also take over spaces traditionally reserved for art to draw attention to certain conceptual concerns within design.

While operating conceptually, Droog is fundamentally rooted in the everyday. Critic Aaron Betsky discerns both a rigorous design sense as well as a fascination with the

vernacular, the environment, collage, and propaganda. He notes, "Droog designers saw their task as gathering objects in the streets, with the designer adding only something invisible: the concept." [22] A contemporary example of their approach is the do-it-yourself philosophy in a series of products produced with the Kessels-Kramer advertising agency: the 'Do Break' vase must be literally 'broken in' in use, as only the act of throwing gives it a unique crackle pattern; and 'Do Hit' is a cube of thin steel that must be pounded into shape by its consumer to function as a chair. Both the conceptual and practical 'function' of such everyday objects entail that they cannot be complete either in a museum or as designed – instead, it is only through (violent) use that they gain their form.

Conceptual design, thus, relates to the conceptual domain of art but also to that of everyday rituals and conventions of use. Form and function, the typical terms of use treated in design, are questioned in terms both of concept and craft. A further example, Kristina Niedderer also draws inspiration from Droog and Dunne & Raby in her theoretical and craft practice. [23] She has taken the genre of the 'abstract vessel' as a basis for a series of 'performative objects', which stimulate 'mindfulness', or reflection in use, by interfering with functionality in various ways. Her 'Libation Cup' has five holes that must be covered with one's fingers such that the contents do not leak out, and 'Social Cups' do not stand independent of being held or interconnected with other cups. In such objects, form and material disrupt the expected 'service role' and 'plan of action' embodied in a conventional object, requiring both attention and physical action to fulfill functional use. Like the 'Do' objects, they require reflection and choice in use – 'use' is where the concept and the craft of familiar forms conflict and must be reconsidered in order to function.

Concept design

For industrial design, trade shows and world expositions have long been arenas for speculative work. In such contexts, the genre of 'concept design' emerged with that of the 'ideal home', 'future city', and 'concept car'. The 1939 New York World's Fair, 'The World of Tomorrow', for example, featured designs by Norman Bel Geddes, Henry Dreyfuss, and Buckminster Fuller, with sponsors ranging from General Motors to Bell Labs. Concept design commonly employed by companies today, whether for internal political reasons, for external competitive purposes, or for gauging desirability among the public. Through non-functioning models or one-off prototypes, design in such contexts is employed to communicate a vision of the future, demonstrate an area of technical innovation, or promote an industry or company. Very often concept designs never go into production, their 'function' entirely at the level of speculation, desire, and persuasion. [24]

In the 1990s, Philips Electronics' 'Vision of the Future' project fulfilled a similar purpose based on a 10-year projection of socio-cultural and technological trends. Along with numerous concept products, and scenarios of their potential role in life-styles and society, it demonstrated collaboration among forecasting, sociology, and advanced technology research within an industrial design context. Another example is the Appliance Design Studio initiative joining Hewlett Packard, IDEO, and the Royal College of Art in the UK. A series of speculative design proposals based on digital photography technology took the form of sketch workbooks, video scenarios, 'under-designed' prototypes and models for stakeholder meetings and public exhibition. In such projects, focus is on social and cultural values as a basis for developing and even challenging the roles of new technological products. [25]

Future projection is essential for the long-term sustainability of industries that depend upon 10- and 20-year lifecycles. As Jan-Christoph Zoels and Silvia Gabrielli point out,

"Like governments and large institutions, corporations like Whirlpool need to gather considerable resources to do large projects; for this they need extensive buy-in from many stakeholders." [26] Whirlpool's 'Project F' applied a range of 'foresight activities' – forecasting methods and user research for considering future lifestyle and environmental effects. The outcome was a number of concept designs commissioned from cutting-edge design firms, aimed at 'intensifying the discourse' among stakeholders. The public and media were explicitly targeted in addition to – and to challenge traditions and assumptions of – existing and potential customer bases. Rather than utopic or dystopic visions, concept designs were challenging statements, a concerted effort to built shared values and future commitments.

Similarly concerned with long-term collective projection, but independent of a particular product domain, 'Sustainable Everyday' is a European program developing visions of environmentally sustainable communities. Conducted as a series of workshops in 10 countries, the outcome was 72 proposals and an exhibition. From observations of 'ipso facto' innovation, design takes the role of leveraging existing and non-designed systems into more general and long-term strategies. Proposals were based on the daily 'functions' of communities, such as cooperative service schemes and micro-entrepreneurship around energy and labor. Laura Balbo argues that "the everyday is not the ambit of the 'familiar' in the sense of routine, of what we take for granted, of the unimportant. It is rather the space-time dimension of each social actor who conceives, articulates and realizes strategies, adding inventive moments to adaptive moments." [27] Here, concept design does not (or not only) take the form of objects but of vision scenarios, foregrounding precedents, practicability, and policy.

Change
Critical practice
'Criticism from within'

Critical design

In interaction and product design, the work that is perhaps most associated with the notion of 'critical design' is that of Anthony Dunne and Fiona Raby. They posit the designer as a critically and materially engaged practitioner – a sort of "applied conceptual artist" – extending the provocative power and situated practice of art. They refer to their work as conceptual design and as critical design, and the focus here will be on those aspects that supplement the above discussion of conceptual design with more critical concerns. Besides conceptual art, they draw inspiration from diverse sources – "Critical design is related to haute couture, concept cars, design propaganda, and visions of the future, but its purpose is not to present the dreams of industry, attract new business, anticipate new trends or test the market. Its purpose is to stimulate discussion and debate amongst designers, industry and the public about the aesthetic quality of our electronically mediated existence." [28]

Early works challenged tenants in mainstream industrial design and HCI. Dunne's 'post-optimal' object, for instance, critiqued the Human Factors preoccupation with the functional, ergonomic, and psychological 'fit' between people and computers. He points instead to metaphysics, poetry, and aesthetics, for example to poet Viktor Shklovsky's notion of defamiliarization or estrangement. Applied as 'user-unfriendliness' and 'para-functionality', this discourages unthinking ideological assimilation and promotes skepticism by increasing the 'poetic distance' between people and things. Exploring the cultural pathologies around technologies, Dunne & Raby look to pop cultures such as science fiction and tabloids, and to sub-cultures such as pirate radio and hobbyists – "Lawyers, criminals and the superstitious are already aware of these issues, designers and architects need to explore them too." [29] Rather than focusing on product fitness, rich narratives and cultural side-effects are explored.

Their 'Placebo Project' shifts the role of design from affirmation of norms to enquiry. Explicitly "taking conceptual design beyond the gallery into everyday life," 8 proto-

types with actual or implied relations to the electromagnetic properties of technology were produced. "Made from MDF and usually one other specialist material, the objects are purposely diagrammatic and vaguely familiar. They are open-ended enough to prompt stories but not so open as to bewilder." [30] Homes were found through ads in the classifieds – 'adopters' lived with an object for some time, with impressions collected in follow-up interviews. For example, Diane and Arabella, adoptors of the 'Compass Table', a coffee table embedded with 25 magnetic compasses, found themselves moving it around their house and plotting various compass readings, in a behavior similar to 'trainspotting'. Thus, personal narratives and emerging behaviors were exposed as relationships with the objects developed over time.

In 'Bioland', design is a vehicle for reflection on the social and ethical implications of biotechnology. A sort of 'existential shopping centre' with 'departments' such as birth, death, and marriage in a genetically modified world, the theme contains a series of products and services. Student projects illustrate possible outcomes: Tobie Kerridge and Nikki Stott's 'Biojewelry' allows bone tissue from two people to be combined, harvested, and used as a material for wedding rings; Shiho Fukuhara and Georg Tremmel's 'Biopresence' stores human DNA in biomatter, such that trees might become an extension of human life after death. Positioning critical design at just outside the science laboratory, Dunne & Raby employ design to transfer abstract knowledge into material culture, through conceptual products, and into public imagination about 'biofutures', through media exposure.

Change
Critical practice
'Criticism from within'

Critical issues

In addition to – or even instead of – developing mainstream practice, foundational theories, or core ideas, these speculations take place on the fringes. While perhaps not directly dealing with or developing central tenets of design, these nonetheless represent a significant 'criticism from within' design with significant presence outside as well. Indeed, conceptual, concept, and critical design, thematically separated as such, traces certain speculative relations to art, industry, and science, with techniques borrowed from crafts, marketing, and politics. Proponents may engage deeply with respective values, methods, and institutional frames. Certainly there might be a danger of such design becoming something else entirely. Rather than a conservative notion of 'design for design's sake' [31] – as in (stereo)typical promotions of 'functional' and 'good' design – there is a danger, for example, of 'design for art's sake'.

While such tendencies may challenge the boundaries that circumscribe the purview and products of design, it is indeed the materiality and aesthetics of design that are foundational – not just for purposes of analysis or commentary, but for crafting constructive counterproposals and projective critiques. Whether taking a utopic or dystopic perspective upon the status quo or the future, the 'products' of cultural, economic, or technological forces are materialized in rather particular ways. As such, design objects may not only situate a socio-aesthetic enquiry in themselves but – by engaging factors of imagination, desirability, and deliberation in use – may open up such critique for wider speculation and debate.

However, Adrian Forty warns against a purely artistic or aesthetic frame of reference for design, which "obscured the fact that design came into being at a particular stage in the history of capitalism and played a vital part in the creation of industrial wealth. Limiting it to a purely artistic activity has made it seem trivial and relegated it to the status of a mere cultural appendix." [32] Indeed, while deploying design materials and strategies, these tendencies take on systemic conditions, alternative forms, and pragmatic operations of design. The idea and reality of production and consumption are examined and critiqued, for example by means of intervention and reframing.

In order to frame a discussion of relations around and within design that might contribute to a more general notion of critical practice, the topics and examples presented above are revisited below with respect to issues drawn out 'Design effects' – 'systems', 'alternatives', and 'operation'. These loosely frame a discussion of such design tendencies in terms of systemic relations and attitudes, alternative material expressions, and modalities of operation and production.

Systems

These approaches have different ways of enquiring into status quo. As the (post-) critical architecture discussion shows, critical positions may be articulated by exposing past conventions, disrupting present-day norms, or projecting possible transformations. While acknowledging that design practice and products are circumscribed within systemic frames, conceptual, concept, and critical design reconsider the status quo by materializing alternatives within the everyday and about the future.

Just as conceptual art mounted a critique of art by challenging existing institutional frames – for example, by transgressing the spatial and symbolic connotations of the gallery through ready-mades and intervention art – conceptual design subverts ingrained expectations of products. Instead of serving utilitarian functions, materials and form are employed to foreground a concept or symbolic function. Conceptual design makes use of conventional institutional frames to assert – and subvert – norms. For example, Droog's pieces and Neidderer's abstract vessels depend upon expectations of utility and familiarity. As 'products' are placed in the art gallery, a certain poetic or critical distance facilitates another relation to 'function'. In the retail context, for example with the 'Do' series, the value of an object is postponed until use, well beyond the scope of design and point-of-purchase. Conceptual design makes use of design norms and institutional frames to reveal alternatives in the present.

Change
Critical practice
'Criticism from within'

Another status quo is explored in Sustainable Everyday. Rather than a realm of unthinking mundanity or static superstructures, the everyday is understood as moment-by-moment invention and 'ipso facto' innovation by social actors. As Ezio Manzini and François Jégou put it: "So, imagining the future means selecting and giving coherence to one or other set of signals (that in turn indicate dynamics in action) and defining an image of a world (or part of it) as it would be, if one of the possible futures were realized. In this conceptual framework, recognizing the signals in the present that allow us to outline various futures, identify those that seem most favorable and increase their chances of success, is what we can define as 'designing the future', or rather, the social construction of the future." [33] Rather than positing (and thus rendering static) existing conventional or institutional frames, this seeks out existing heterogeneity, amplifying local agency and ongoing choices from the bottom-up.

In imagining possible futures, concept and critical design negotiate utopic and dystopic visions. Concept design involves extrapolation from a selection of present conditions into, for the most part, desirable or preferred visions of the future. Project F explored "how design helps to create an imaginable future – one leading to a richer response from customers and citizens, and to more relevant information for decision-makers." [34] Bioland, in contrast, develops scenarios that are entirely feasible but morally and ethically provocative. Not unlike Koolhaas' 'Market Realism©', an ironic take on utopic modernist notions of Socialist Realism, Bioland blatantly draws on shopping and marketing mechanisms, with the explicit intent to engage people – not as citizens – but as consumers. As a sort of 'retail outlet' materializing and distributing concepts from the science lab to the popular imagination, Bioland operates in an ambivalent zone between emerging science and contemporary material culture, problematizing possible, even probable, futures.

Rather than academic analysis or historical retrospection, basing a commentary, projection, or critique in design requires a certain acceptance or appreciation of the status quo in order to operate. This may be a basis for subversion, diversification, or even celebration. Rather than prompting outright opposition or a retreat into 'waiting for the revolution', the status quo is a basis for articulating alternatives.

Alternatives

Alternatives and change, invited or opened through design means, must nonetheless be activated and achieved in ongoing use. Another way of considering artifacts as persuasive arguments or forceful propositions is in terms of how they invite 'active critical participation' into ideas and their alternatives. Like Superstudio's ambition to design for the lifelong 'be-in', products of conceptual, concept, and critical design might create openings for reflection, debate, and reinterpretation in use.

Conceptual, concept, and critical designs often evade ordinary consumption in order to function conceptually. As Dunne and Raby put it, "These objects are clearly not intended for production, but are designed to provide mental pleasure and stimulate reflection. They are products for the mind... Their abstract form signals that they are intended to be used in the imagination." [35] Post-optimal objects, such as those with placebo effects, act as a backdrop – or provocation – for the emergence of personal narratives or cultural pathologies. While working with particular instantiations in the present and often proximate consumption (whether in a gallery, store, or in daily use), such approaches might also stimulate personal projection – reflection upon more generalized or cultural use, or upon possible futures.

Change
Critical practice
'Criticism from within'

Form may go beyond 'forceful propositions' to require active participation. While built to accommodate, discomfort, or persuade users in various ways, the actual effects of 'placebo' objects evolve in use. Droog's unremarkable vase and steel cube gain unique value only through (violent) use. Niederrer argues, "Only through action does function become fully apparent. In other words, function becomes complete only where form (the object) is put to use." [36] She takes this on, crafting objects in which utilitarian function is contingent upon conceptual function. It is only by coming to terms conceptually with the dysfunction built into 'Libation Cup', and adapting one's behavior accordingly, that the utilitarian function of drinking can be achieved. In such examples, a concept is only realized as it achieves reflection – by action, in use.

In such approaches, concepts or critiques are materialized in particular ways. Eisenman's diagrammatic or 'cardboard architecture' is to be literally 'read' as a record of a process, rather than a final product. In the Placebo project, objects are constructed from basic and ready-made materials to evoke – rather than solve – electromagnetic issues. Concept design operates publicly and politically – 'underdesigned' objects and scenarios sketch possible futures to drive collective change in the long-term. In these cases, the sensory experience of materials and form are reduced, such that reflection might take over – whether as a cognitive reading or projective narrative.

Others make use of the personal significance or cultural symbolism of materials. High and low materials are often mixed in conceptual design. Precious substances, technology, and trash may be combined to expose issues of taste, habit, and memory – even material scarcity may speak to ethics and (over-)consumption. [37] Indeed, Niederrer carefully crafts her objects, employing precious materials and frames of art and ritual in order to mix between conceptual reception and performative experience in use. These approaches employ materials and form deliberately, crafting arguments and propositions as 'physically perceptible and experiencable facts' that might situate and invite various forms of reflection and participation.

Operation

Between design practice and material product, issues of production intervene – entailing a gap between the ideas involved in design and ideas involved in use. This implies that issues of production are not only important, but ideologically significant. On one hand, issues of logistics and procedures may be taken on explicitly, as in post-critical architecture. For example, in his Euralille project, Koolhaas treats 'cheapness' as design ideology, constructing a practice where designers, clients, and politicians are "shackled by mutual obligation" in a "dynamic from hell." [38] Or, on the other hand, the gap may be lessened through 'maker'- rather than 'market'-led practice. For example, craft production based on direct commissions or retail cooperatives entails that much can be exposed about the skill, technology, and ideology involved. Between such extremes, there is of course a range of other possibilities.

Some conceptual designers understand that working in and through existing systems of manufacture may itself be a form of critical practice. Anti-design groups engaged with manufacture, producing objects for both art and retail contexts. This was possible in Italy at the time due to a unique manufacturing environment of 'piccola impressa'. [39] Today, in Japan, 'Just In Time' and cellular rather than linear production enables the global release of experimental products. In both cases, one-offs and small batches may be more easily produced, and more rapidly scaled up to mass-manufacture. Indeed, part of Droog's success lies in bridging craft and mass-production: hand-made qualities have been translated into large-scale manufacture; and certain products are available in unique one-off or as a mass-produced version.

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Critical practice
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Dunne & Raby acknowledge that objects critical of industry's objectives are unlikely to be sustained within such a system. Besides altering existing systems, there is also a range of alternative modes of production. Conceptual and concept designs are often produced for publication and exhibition, following a long tradition of 'paper architecture'. [40] Concept designs such as Project F and Sustainable Everyday are made for specific channels of production that do not include manufacture – instead, they are produced directly for public exhibition, book publication, and the media. Indeed, Project F challenged both corporate values by leveraging discourses in academia and mass-media. Such approaches reposition design in relation to the production mechanisms – and values – of other institutional frames.

Another example of institutional reframing is increasing presence of conceptual and critical design in art contexts, through exhibition in prominent venues and publication in associated catalogs or reference books. Certainly such contexts act as modes of (re-)production. For example, objects featured may be hand-crafted as one-offs, they may already be mass-produced for sale, or they may be the products of research projects where such objects are merely part (and perhaps a minor part) of the 'production of knowledge' in academic contexts. Thus, the art context may operate as a means of critiquing a hegemonic system or for reframing the terms of ideological production. Such arenas may supplement or collide with the values of industrial, market, or academic contexts, leveraging a new discourse altogether.

Such modes of (re)production and institutional reframing develop a more complicated picture of the critical possibilities. On one hand, 'critical practice' might be seen as a negotiation of conditions in production and manufacture to change existing material reality. On the other hand, it might be seen in relation to the development of alternative channels and modalities for the production of ideas and discourse.

Toward critical practice

This discussion of (post-)critical architecture and conceptual, concept, and critical tendencies in product design sketches a range of issues for critical practice. Architecture has long debated the role of the designer and the design object in posing a critique. Carving out the terms of debate decades ago, distinctions were made between the respective concerns of history, theory, and practice and to locate an intellectual basis proper to architecture for relating to 'critical theories' shaping academic thought in the humanities and sciences. In product design, there is less distinction, or even basis for distinction, between the profession and the discipline, and thus for negotiating competing intellectual, ideological, and operational concerns. Without the discourse around criticality present in architecture, there is some consequent difficulty in locating the terms upon which alternatives to mainstream practice might be based, or a 'critical distance' from other related approaches qualified.

Today there is a curious intersection between criticality in architecture and in product and interaction design. At the same time as post-critical architects are engaging with the material, procedural, and political conditions that circumscribe building, product and interaction design are attempting to establish critical terms and construct theoretical bases. In architecture, post-critical proponents such as Koolhaas revel in statistical and ethnographic data, the logics of marketing and consumer science. After decades of rigid distinctions and retreat into autonomy by 'critical architecture', the terms 'critical' and 'practice' may be paired – but not outside "the 'real practice'," as R.E. Somol articulates, "already constituted by vast documents of abstraction – building and tax codes, market projections and interest rates, ordinances and zoning laws, actuarial tables and demographic statistics." [41] Parallel to this pragmatic turn in architecture, calls for 'thoughtful' and 'reflective' approaches in HCI and interaction design resonate with pragmatism – which has perhaps had more influence as a theoretical basis than critical social science or critical social theory.

As the professional terms of market logics and popular culture have long determined almost all of what happens within product design, conceptual, concept, and critical designers are seeking and creating alternatives. To evade standard modes of production and consumption, some return to maker- rather than market-led terms of crafts and to art and the media as forums for criticism and debate. The fads and fictions of pop culture and the techniques of persuasive design and marketing are engaged, but to different ends than service to culture or capital. Indeed, Dunne & Raby turn back to the logics of established modernist aesthetic theories, long explored within 'critical architecture' – "Many issues touched on here, such as art's relation to everyday life, and the need for art to resist easy assimilation, overlap with those already addressed by the Frankfurt School and others in relation to disciplines such as music (Adorno), painting (Marcuse), art (Benjamin) and drama (Brecht)." [42] While architecture seeks to escape the rigorous and restrictive distinctions of past conceptions of criticality, product and interaction design seek to establish the terms for critical practice.

However, the intellectual and ideological terms explored by conceptual, concept, and critical design are perhaps not those proper to any single disciplinary project. These tendencies operate 'at the edges (of fashion, price or taste),' to borrow Rees' turn of phrase – whether by explicit intent or because practices critical of industry's objectives are unlikely to be central to a discipline itself oriented in primarily industrial terms. At the edges, such tendencies actively disrupt, transgress, or manipulate conventional values or mainstream understandings. This might be precisely what makes such statements hard to ignore – we might even argue, as Silvetti does, that such critical voices and dissenting examples are necessary for developing a disciplinary

discourse. However, such tendencies in product and interaction design do not only operate at the edges in order to establish a 'critical distance' from a disciplinary center, as perhaps more typically characteristic of 'criticism from within' architecture.

Conceptual, concept, and critical design deliberately cross boundaries into other domains, such as art, industry, and science. On one hand, this allows the introduction of multiple and even competing concerns, which may be played off one another to orient alternative ideas, values, and concerns. For example, the institutional reframing of conceptual design in terms of art – through methods of production or context of consumption – allows an entirely different relation to ideological concerns. On the other hand, design materials and form may be employed to materialize 'forceful propositions' about concerns located outside of design. For example, concept design may employ product models and use scenarios to support alternative ideological agendas within an industrial or media context. In the first case, design operates from the edges or even outsides to escape or challenge the center, in the second, design is a basis for operating in specific ways outside.

In both cases, since critical terms are hard to locate – even intentionally mixed up and manipulated across disciplinary borders – the basis and terms of 'criticality' are by no means given. Indeed, at the edges, conceptual, concept, and critical design tread a fine line. Persuasive visions of the future materialized by concept or critical design might promote sustainability or stimulate product sales, question biotech futures or actualize sci-fi extremes. As 'paparazzi' intercepting innovations leaving science lab, critical design operates in an ambivalent space between glossy magazines and art criticism. Escaping the product marketplace, conceptual design only enters into the alternate terms of commodification within the art world. Such issues suggest both possibilities and problems for critical practice.

Expanding the purview of design entails that intellectual and ideological bases, and terms of production and consumption, are multiplied and distributed. Facing not only inwards towards disciplinary foundations, such tendencies reach out to implicate other domains and audiences. This implies the need for precise positioning of ideas and intentions, both in design materials and form, but also as appropriate to different contexts. For example, the reading or experience of the same critical object may be entirely different as presented in a gallery or a trade show, in an art journal or scientific publication, and in different countries. Further, conceptual, concept, and critical design might be said to represent a shift away from the spatial object in and of itself to the ideas behind, and to engagement with such ideas by audiences or users. This entails that the disciplinary bases and operational terms circumscribing the idea become central not only to posing a critique but to positioning its wider reception.

Such issues make these approaches particularly relevant to any critical practice in interaction design. As a multi-disciplinary field, interaction design explicitly deals with the combination of technical and design concerns – not to mention any range of other domains and disciplines implicated in the social construction and use of technological objects. Besides certain difficulties in locating disciplinary bases and critical terms, there are particular issues of materials and form, consumption and use.

Instead of affirming or acquiescing to 'industry's technological agenda', critical practice in interaction design must contest the terms by which technology and design are related within practice. Rather than 'design for design's sake' or 'technology for technology's sake', as might characterize conservative design or technical practice, relations between must be investigated and challenged. Certainly conceptual, concept, and critical design present some approaches to exploring and exploiting

disciplinary norms and boundaries. Exposing both possibilities and problems, such tendencies also demonstrate the need for more precise positioning of concerns, intentions, methods, and presentation. In this sense, critical practice cannot just be about any single or absolute basis for relating to 'criticism from within' or 'critical theories' introduced from this out, since the 'insides' and 'outsides' circumscribing interaction design are by no means clear-cut nor finally determined.

Besides better understanding the basis for critical terms and practice, there are concerns particular to interaction design discussed in previous sections of this text that must also be accounted for within critical practice. For example, treating 'technology as material' opens up for the material conditions particular to industrial design. The form of technological objects includes aesthetic expressions and functional behaviors that change over time – further, interactivity entails that processes of use directly determine how computational processes – and thus temporal form – unfold. Thus, not only does design extend even further into use, since the form of technological objects occupies not only space but time, but use may be considered as a form of participation in the formation and long-term sustainability of such objects. Such issues might situate the particular concerns of interaction design in opening up for 'active critical participation' in cultural and societal change.

The approaches discussed here do suggest some possibilities for treating 'temporal form' and 'use as participation'. Indeed, architecture makes it clear that in order to move beyond mere quotation and commentary to pose a critique, the most powerful and critical potential of design is in material form and behavioral transformation – as 'physically perceptible and experiencable facts'. This is precisely what differentiates design – as a material practice – from hermeneutic practices of interpretation and analysis. As Mary McLeod notes:

> But just as architecture is intrinsically joined to political and economic structures by virtue of its production, so, too, its form – its meaning as a cultural object – carries political resonances. Owing to its utilitarian value, its political impact may be more diffuse, if more sustained than that of other arts. Buildings are rarely perceived at once for their aesthetic qualities and 'content'; rather their impact occurs gradually through use and repeated contact. From this perspective, spatial configurations, tackle qualities and functional relations are as important as figurative dimensions in architectural reception. [43]

While perhaps inevitably located at the edges of fashion, price, and taste, criticality may extend into use by means of built form. Through renovations and changes in critical reception, Eisenman's House VI continues to raise questions. Her family grew up in the house, living with its functional disruptions on a daily basis, and Suzanne Frank still reflects – "And I ask myself, will I continue to like being challenged by House VI's architectural poetics and puzzles as time passes and old age draws nigh?" [44] Temporality is more subtly engaged in Diller + Scofidio's 'embodied conceptual art'. For example, travel speed is manipulated in their 'Slow House', articulating transitions between public space and private property, work and leisure. In 'Blur Building', an 8-minute delay between the weather sensing and fog-emission technologies means that the whole is in a continual cycle of dispersion and reconstitution. From the obtrusions of 'difficult forms' to post-critical performativity, temporality of materials, composition, and use may be explicitly engaged.

Conceptual, concept, and critical design also explore use. While short-term adoption may not approximate the 'domestication' of real products, the Placebo project probes into personal narratives and cultural pathologies that might arise from living with

critical designs. Droog's 'Do' objects and Niedderer's abstract vessels interweave conceptual consumption and functional use in provocative ways. However, there are limits to exploring the idea – and not the actuality – of use. The maker-led production of one-offs for exhibition, non-functioning and 'underdesigned' models for expos, and 'paper architecture' destined for the media – these certainly make use of design materials and form to engage a different sort of debate, even reaching a much larger audience. But altering the terms of production relocates consumption altogether. The danger is that the some effects – and power – of critical designs might stop at the point of production – restricted to gallery spaces, display cases, or the printed page.

Design certainly may take on roles that are conceptual or discursive. However, the advantage of design is that it might go beyond rhetoric by means of material form, everyday utility, and ongoing interaction. As Richard Buchanan points out, "If products affect and shape attitudes, they do so not only through persuasive assertion, which may be recognized or not. Beyond this, users must then carry out their own deliberation about whether or how to use products in the future." [45] As the products – conceptual or material – of design practice enter the world, its inscribed ideas, values, and use become open to deliberation and interpretation, affirmation or further critique. Just as design moves beyond commentary through material transformation, critical designs must be used in order to effect behavioral transformation. Indeed, it is precisely material form – 'physically perceptible and experiencable facts' – that might allow for new forms of use as 'active critical participation.'

Understanding design as an inherently ideological practice, interaction designers may employ both traditional and technological materials to open up such ideas for reflection, debate, and even reinterpretation in use. Use involves a range of other ideas – and ideologies – that also come into play in personal, social, and cultural practices. As Charles Rice articulates, "'critical' problems occur when projects founded in an opening up of critical experiential possibilities as part of a design process are then, as concrete buildings, confronted by the inherently critical experiences of actual subjects." [46] A focus on temporal form and use as participation opens up new questions – such as how a critical design relates to reflective use, and, vice versa, how 'active critical participation' might determine design. We must ask how thinking and making in interaction design – as 'problem-finding' rather than 'problem-solving' – might enquire into ongoing relations between critical design and critical use.

Since the temporal form and interactivity of technological objects depends upon use, and use over time, critical practice in interaction design must take on such issues. Certainly, we must further reflect upon and locate bases for the choices and ideas involved in design practice and processes. Additionally, we might consider how the products of interaction design open up for competing ideas. Material combinations and the interplay of spatial and temporal form allow for other relations between technical and design concerns, between ideas in design and those in use, which also might be the subject of critical practice. It is precisely notions of temporal form and the form of interaction – a give-and-take between practices of critical design and of critical use – that should be central to interaction design. Certainly, some such ideas have been touched upon here, which will be among those discussed more concretely in the next section, by way of reflections upon the design research program 'Static!'

Notes

1 Blauvelt, curator and ed., *Strangely Familiar*, 37.

2 Dunne, *Hertzian Tales: Electronic Products*, 109.

3 Thackara, "Beyond the Object," in *Design after Modernism*, ed. Thackara, 22.

4 Rees, "Patterns of Making," in *Culture of Craft*, ed. Dormer, 130.

5 See, for example, Blauvelt, ed., *Familiar*; Robach, curator and ed., *Konceptdesign*; d'Ailly, Olausson, and Sten, curators, *Extra Ordinary*.

6 Dunne and Raby, *Design Noir*, 59.

7 Dunne and Raby, *Noir*, 59.

8 See, for example, Floyd, "Being Critical in, on or around Computing?", *Proceedings of Critical Computing*; Agre, *Computation and Human Experience*. For background on Participatory Design see the section 'Participatory practice'.

9 See Schön, *Reflective Practitioner*; Löwgren and Stolterman, *Thoughtful Interaction Design*; Sengers, Boehner, David, and Kaye, "Reflective Design," *Proceedings of Critical Computing*; Sengers, McCarthy, and Dourish, "Reflective HCI," *Proceedings of CHI*; Hallnäs and Redström, *Interaction Design: Foundations, Experiments*; Redström, "Designing Everyday Computational Things" (PhD diss.).

10 For comments on the profession versus discipline of architecture see Hill, "Institutions of Architecture," in *Offramp*; Hill, "An Other Architect," in *Occupying Architecture*, ed. Hill.
For background on criticality in architecture see Hays, ed., *Oppositions Reader*; Hays, ed., *Architecture/Theory/since 1968*; *Lotus International*.

11 Jameson, "Architecture and the Critique of Ideology" (presentation, 1982), reprinted in Hays, *Architecture*, 151. See also Agrest, "Design versus Non-Design," *Oppositions*; Tafuri, "L'Architecture dans le Boudoir," *Oppositions*; Dal Co, "Criticism and Design," *Oppositions*.

12 See Silvetti, "The Beauty of Shadows," *Oppositions*.

13 See Hays, "Critical Architecture: Between Culture and Form," *Perspecta*, 16.

14 Allen, "Its Exercise, Under Certain Conditions," *Columbia Documents*, 95. See also, Baird, "'Criticality' and Its Discontents," *Harvard Design Magazine*; Jarzombek, "Critical or Post-Critical?" *Architectural Theory Review*; Martin, "Critical of What?," *Harvard Design Magazine*.

15 Koolhaas, quoted by Beth Kapusta, *Canadian Architect Magazine*, 10. For further background on Koolhaas, refer to the section on 'Becoming users'. See also, Diller and Scofidio, *Blur: The Making of Nothing*; Sarkis, "On the Line Between Procedures and Aesthetics," in *Pragmatist Imagination*, ed. Ockman.

16 Diller, in Eisenman et al, "Eisenman (and Company) Respond," *Progressive Architecture*, 88. See also, Eisenman, "Cardboard Architecture: House 1 & 2," in Eisenman et al., *Five Architects*; Frank, *Peter Eisenman's House VI*; Diller and Scofidio, *Flesh: Architectural Probes*; Betsky, Hays, and Anderson, *Scanning: The Aberant Architectures*. For further background on Eisenman, refer to the section on "Design effects."

17 Allen, "Its Exercise," 95.

18 De Carlo, "Il pubblico dell'architettura," *Parametro 5* (1970), reprinted in *Architecture and Participation*, ed. Blundell Jones, Petrescu, and Till, 14. See also Hatton, "Exploring Architecture as a Critical Act," *Architectural Research Quarterly*.

19 Cf. the use of terms in Baird, "Criticality"*;* Dunne, *Hertzian*; Eisenman, "Notes on Conceptual Architecture," *Design Quarterly*; Lum, "Conceptual Matter: On Thinking and Making," *Harvard Design Magazine*; Robach, "Critical Design," in *Shift: Design as Usual*; Robach, *Konceptdesign.*

20 See, for example, te Duits, ed., *Origin of Things*; Kristoffersson, "Memphis och den Italienska Antidesignrörelsen" (PhD diss.); Lang and Menking, *Superstudio: Life without Objects*. For further background, refer to 'Design effects.'

21 Margetts, "Objects of our Time" (exhibition catalog), unpaginated. See also, Lees-Maffei and Sandino, "Dangerous Liasons," *Journal of Design History*. For background on Droog design see, for example, Bakker and Ramekers, *Droog Design: Spirit of the Nineties;* Horsham, "What is Droog?" *Blueprint*.

22 Betsky, "The Strangeness of the Familiar in Design," in *Strangely Familiar*, ed. Blauvelt, 51.

23 Niedderer, "Designing the Performative Object" (PhD diss.).

24 See, for example, Bell, *Concept Car Design*; Gelernter, *1939: Lost World of the Fair*; Schafer, "Designing Inefficiencies," in *Scanning*, ed. Betsky, Hays, and Anderson.

25 See Philips Design, *Vision of the Future*; Gaver and Martin, "Alternatives: Exploring Information Appliances," *Proceedings of CHI*; Martin and Gaver, "Beyond the Snapshot," *Proceedings of DIS*.

26 Zoels and Gabrielli, "Creating Imaginable Futures" (report), 19. See also, Gabrielli and Zoels, "Creating Imaginable Futures," *Proceedings of DUX*.

27 Balbo, quoted in *Sustainable Everyday*, ed. Manzini and Jégou, 14.

28 Dunne and Raby, *Noir*, 58.

29 Dunne and Raby, *Noir*, 26. For a discussion of the 'post-optimal' object see Dunne, *Hertzian*.

30 Dunne and Raby, *Noir*, 75.

31 See also Bloemink and Cunningham, eds. *Design ≠ Art: Functional Objects*.

32 Forty, *Objects of Desire: Design and Society*, 6.

33 Manzini and Jégou, eds., *Sustainable Everyday*, 16-17.

34 Zoels and Gabrielli, "Creating" (report), 3.

35 Dunne and Raby, *Noir*, 64. See also Dunne, *Hertzian*.

36 Niedderer, "Exploring the Expressive Potential of Function," in *Craft in Dialogue*, ed. Jönsson, 50.

37 See, for example, Attfield, *Wild Things*; Robach, *Konceptdesign*; Sandino, "Here Today, Gone Tomorrow," *Journal of Design History*.

38 Koolhaas and Mau, *S, M, L, XL*.

39 See Burkhardt, "Design and 'Avant-Postmodernism'," in *Design after Modernism*, ed. Thackara.

40 See Cook, ed., *Archigram*; Tschumi, Forward to *Manhattan Transcripts*; van Berkel and Bos, eds., "Diagram Work," *ANY*; de Zegher and Wigley, ed., *Activist Drawing*.

41 Somol, "Architecture without Urbanism," in Allen, *Points and Lines*, 138.

42 Dunne, *Hertzian*, 68.

43 McLeod, "Architeture and Politics"(*Assemblage*, 1989), reprinted in *Architecture/Theory/since 1968*, ed. Hays, 682. See also Allen, "Practice vs. Project," *Praxis*. For further background, refer to section on 'Material practice'.

44 Frank, *House VI*, 72.

45 Buchanan, "Declaration by Design: Rhetoric, Argument," in *Design Discourse*, ed. Margolin, 107.

46 Rice, quoted in Hatton, "Critical Act," 107.

Change
Critical practice
Notes

Static!

Change

Static!

Static! is a design research program investigating interaction and product design to increase awareness of how energy is used in everyday life.

Focus within the energy sector tends to be on efficiency of energy technology or on information and marketing campaigns. In architecture, energy and other service systems tend to be hidden away, and, in product design, concern tends to be on individual products rather than a lifestyle or household perspective.

Energy is already basic to the use and expression of everyday things – from ordinary lamps to proliferating electric and electronic products. Acknowledging this, our approach enquired into how energy is made present in domestic life through the design of everyday things, and how the design of expressions and interactions might lead to an increased awareness of energy use and choice on an ongoing basis.

As a basis for working with energy in design, we explored energy as a material that might be more visible and experiential in design and in use. Thus, we shifted from thinking about it as something merely to optimize or hide away, but as an essential and expressive material in building the form of things used everyday. This turns attention to energy as a central aesthetic and functional issue in early stages of design.

Revisiting the design of everyday things, we developed a palette of design examples in the form of prototypes, conceptual proposals, and use scenarios, as a basis for discourse with users and designers. We enquired into:

• Energy conceived not only in technical but aesthetic terms, thereby integrating design and engineering concerns, and;

• Energy use – not only in terms of utility and ease-of-use – but as critical reflection through the expressions of and interactions with objects in everyday life.

Static! explored the possibility, indeed the responsibility, of exposing choices, alternatives, and consequences through design – in other words, critical reflection in design and in use.

A pre-start phase within the program overlapped with IT+Textiles, building on and extending a common ground between aesthetics and engineering perspectives as well as integrating competence and partners. To launch the program across multiple locations, initial studies were conducted by program participants to gather inspiration and information from ordinary households. Images, notes, and impressions from 'cultural probes' and in-depth interviews were the basis for workshops and concepts further developed in projects.

Outcomes in the form of design examples, publications, and exhibitions have been targeted to impact and involve various stakeholders, including industry, municipal agencies, academia, media, and the public sector. Deployment of design examples spans from long-term studies and commercial prospects to local interventions and public debate.

Brief descriptions of three – from among many – projects developed within the program are presented here. The program and all the projects are more extensively documented elsewhere. [1] These three projects are a basis for further reflection here on concerns of 'critical practice'.

Scope
1.5 years, 2004-2005

Program manager
Christina Öhman

Research Directors
Sara Ilstedt Hjelm
Ramia Mazé
Johan Redström

Partners
Front, Göteborg Energi, Ludvig Svensson, Mälardalen University, School of Design and Crafts (HDK) at Göteborg University, Swedish Industrial Design Foundation (SVID), Swedish School of Textiles at the University College of Borås, University of Art and Design Helsinki (UIAH)

Sponsor
Energimyndigheten (the Swedish Energy Agency or STEM) with additional support from Region Västra Götaland

Energy Curtain

The *Energy Curtain* collects energy when the sun shines on it, saving and storing energy during the day to light the room once the sun has set.

The curtain has two sides – one facing outside with solar cells and the other woven with fiberoptics, cotton, and even afterglow and reflective materials. Sunlight gathered during the day is collected and stored in batteries. When insufficient light is sensed as the sun sets, battery-powered LEDs distribute light along the optical fibers woven into the textile pattern.

A range of technical and traditional materials are thus integrated into the weave and physical construction. In addition to the static aesthetics of the curtain's textile design and familiar form, the object gains a dynamic, glowing aesthetic pattern in the evening.

Project team
Anders Ernevi
Margot Jacobs
Ramia Mazé
Carolin Müller
Johan Redström
Linda Worbin

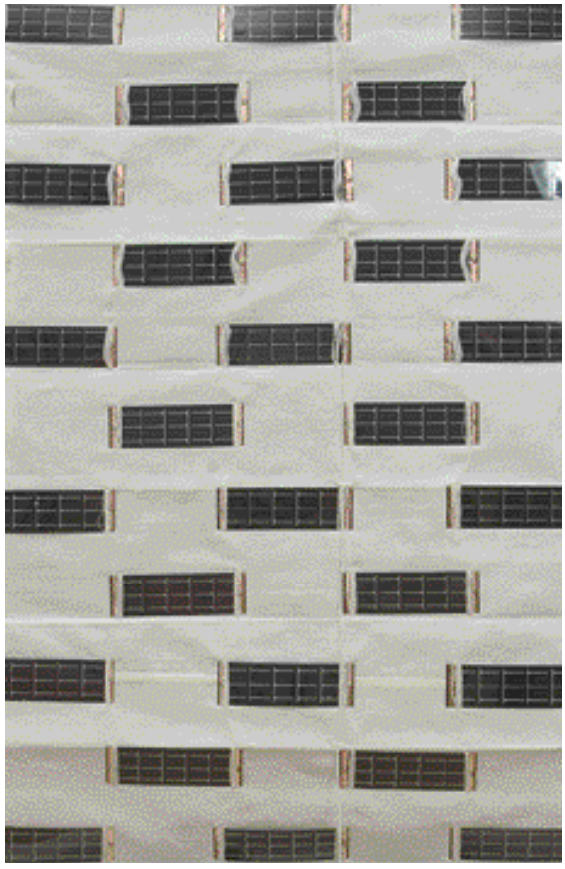
Study by
Ilpo Koskinen
Sara Routarinne
(UIAH)

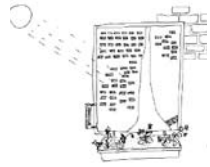
Concept
The project reinterprets our familiar relation to curtains as a means of controlling the light in a room – but with a conceptual twist. Since generated light is in direct proportion to collected light, use requires an explicit choice of how much light to collect based on the extent to which the blind is drawn during daylight hours. Users must choose whether to open the curtain and enjoy the daylight or to close it and save energy for later.

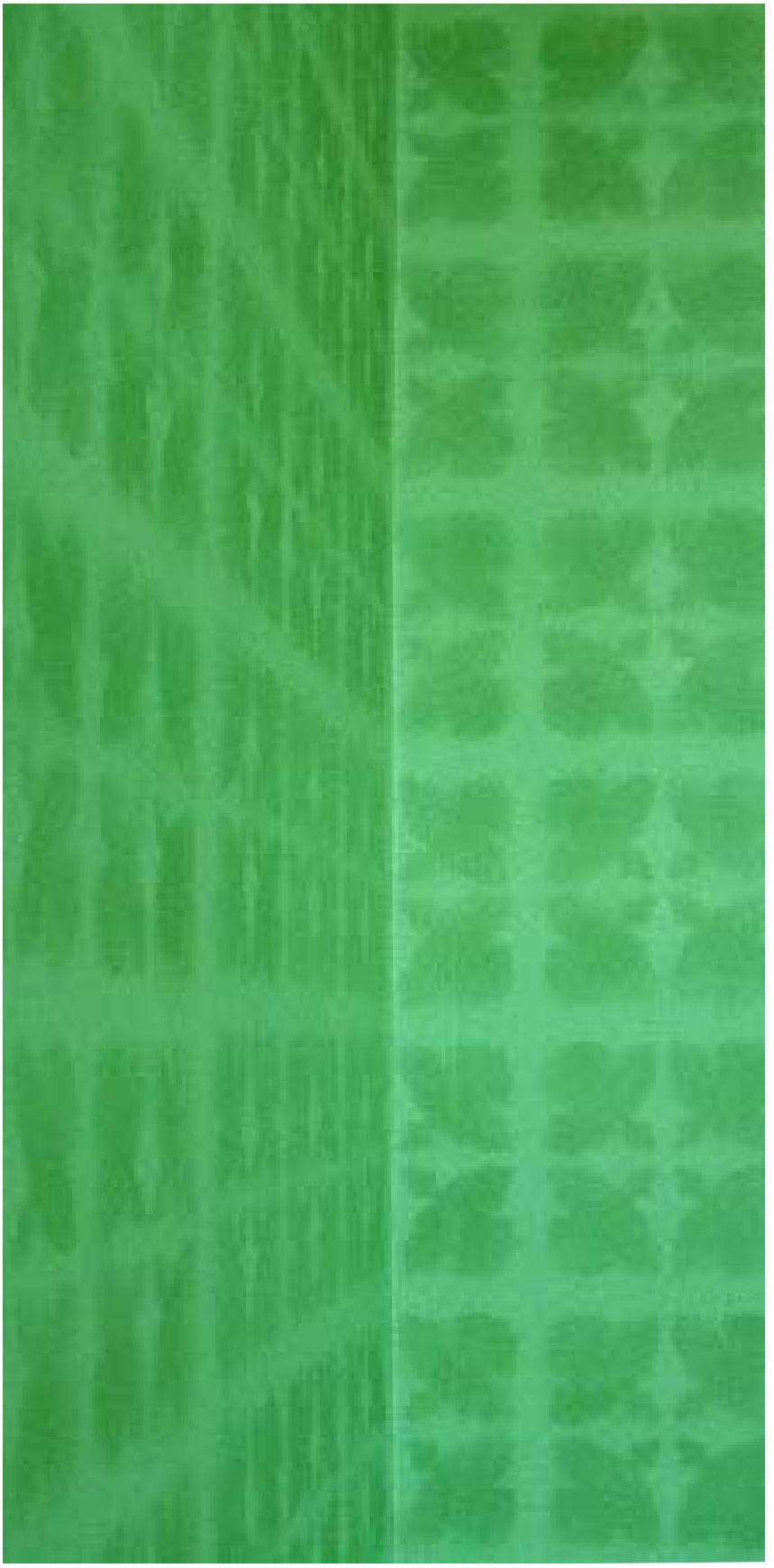
Control over a complete energy cycle is thus put directly and literally into users' hands, requiring a trade-off between consuming or saving energy on a daily basis. In this way, the object acts to stimulate reflection on the costs and effects of consumption. The prototype is the basis for considering how people might evolve a relationship with such a self-sustaining object and their own energy behaviors over time.

Outcome
Several versions of the Energy Curtain have been built, including one fashioned as a horizontally-folding Roman blind and another as a series of vertical Lamellae panels. One prototype is currently the subject of a long-term domestic study using ethnographic methods.

Prototypes have also been developed in collaboration with textile manufacturer Ludvig Svensson, to explore the possibilities of integrating the technology into their textile manufacture and the aesthetic qualities into their existing product line.







Front examples

For several months, the conceptual product design group Front were involved in the project as an external design unit, injecting their unique approach and collaborating in the development of a variety of concepts. Their approach is characterized by poetic irony, frequently involving nature and chance in formgiving.

As part of Static!, a series of lamps, tiles and wallpaper were developed both as concepts and, to some extent, as working prototypes.

Front project team
Sofia Lagerkvist
Charlotte von der Lancken
Anna Lindgren
Katja Sävström
with
Göran Nordahl
Sofia Stattin
Spets

---

in collaboration with the POWER studio, Interactive Institute

Outcome
Two lighting concepts explore how energy and use might together determine form. The lampshade of the 'The Heat Sensitive Lamp' is made of a heat-sensitive paper material, typically used in relief wallpaper. When the lamp is turned on for the first time, the heat (from the wattage and shape of the lightbulb) causes the material to bubble and change – or de-form.

Similarly, in the 'Flower Lamp', energy use causes change to the form, but in this example the formation is ongoing. Connected to a household's energy meter, the Flower Lamp-shade expands or contracts depending on energy consumption over the course of weeks and months. As a sort of aesthetic reward system with both a functional and aesthetic presence in the family room, it 'blooms' if overall energy use decreases.

Two other interior concepts reflect patterns of energy in domestic space that may have long since become invisibly incorporated into our expectations and habits.

Amplifying rather than protecting wallpaper from the effects of UV-light, 'Appearing Pattern Wallpaper' visualizes aesthetic qualities of this natural energy source. Over the wallpaper's long lifespan, hidden patterns in the monochrome surface slowly appear where it is exposed to sunlight.

Energy taken for granted or leaked is also explored in 'Disappearing Pattern Tiles'. These bathroom tiles are decorated with thermochromic patterns, which fade away where water is splashed or very hot.

All together, these interior objects and surfaces probe into the aesthetic and conceptual effects of energy, both as an undervalued presence in everyday life and as an agent in formgiving.

Free Energy

Free Energy proposed design examples to spark a debate in everyday public situations about energy use.

Borrowing from mundane aesthetic and behavioral 'vernaculars', two prototypes were designed to make energy use or choices explicit. In order to investigate the role of these in stimulating self-reflection and debate, a series of 'energy interventions' were staged, involving installation and observation of the prototypes in public.

Project team
Anders Ernevi
Ulrika Löfgren
Margot Jacobs
Ramia Mazé
and
Sara Danielsson (HDK)

Outcome
The 'Energy Tap' and 'Kinetic Door' were the 2 low-tech prototypes implemented. The Energy Tap is a self-sustaining energy outlet for open use – anyone can crank and thus charge up any product for any purpose. Borrowing an interaction metaphor from the commercial crank radio and designed to blend into the vernacular of urban public utilities, it consists of a modular stand with a crank for generating energy.

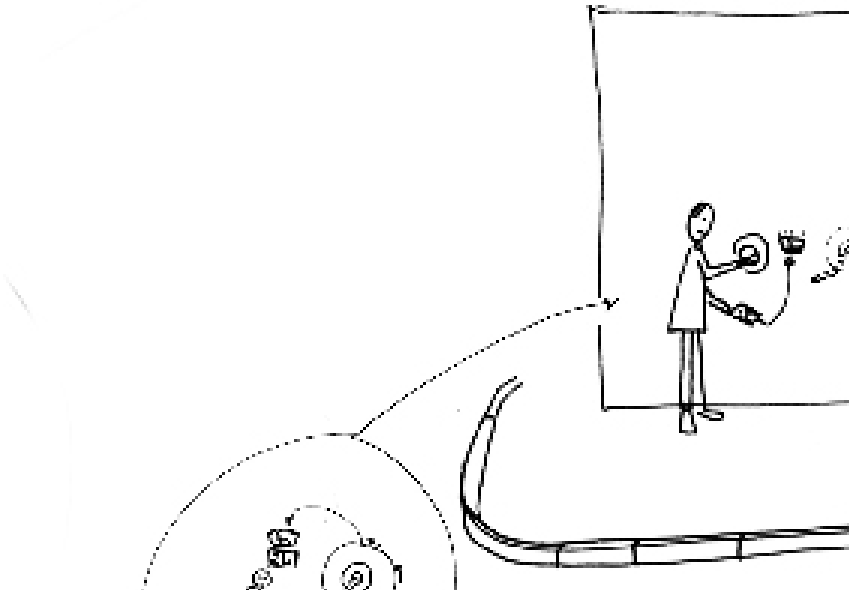
The 'Kinetic Door' intervenes into the mundane choice of using ordinary or revolving doors to access a building – a choice that impacts heat and thus energy conservation. The prototype consists of a wheel that attaches to any revolving door – when the door is pushed, it sparks an aesthetic lighting pattern to reward door-pushers for their eco-friendly effort.

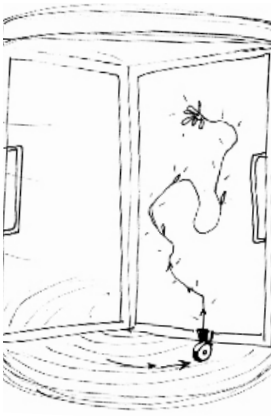
The Energy Tap operates as an open object without a fixed location, and the Kinetic Door is a redesign or parasitic supplement to ordinary objects.

During a series of four interventions in public parks and plazas, people's reactions and behaviors with respect to the objects were captured through observations and interviews.

Reactions ranged from bewilderment to appropriation, and in some instances discussions among multiple passers-by. Comments ranged from the utilitarian to the utopian, for example: 'I would use it to recharge my car or my future car', and; 'I love the idea of free energy that is all about releasing energy into the world… with free energy, people would be more connected … maybe people would get out of their houses and throw parties in the street and get to know each other better.'

Employing the objects in interventions fueled new inspirations and concepts in our design process and stimulated a lively local debate.





The sections on 'Design effects' and 'Critical practice' raise a discussion about the powerful role of design in shaping ideas, behaviors, and activities. While the ever-increasing range and functionality of design products seems to promise ever more choice, to some extent this obscures how they determine ways of life. Design enables and disables possibilities in use – thus exerting power and moral authority and effecting social, ideological, and political change. As the spatial form of the built environment determines movement and perception, for example, it literally disciplines behavior and experience. Further, since technological objects involve the design of temporal form and unfolding interactions, the act (and thus the intention) of design extends to an even greater and more lasting extent into use. In interaction design, thus, we must reconsider our role and responsibility towards future use and long-terms effects, since we are predetermining it to a much greater extent.

From a design perspective, is not enough to conclude that technology is socially constructed without a conception about how alternative constructions might matter and what they might be like. There has long been a vivid debate in discourse and practice about how design might contest or critique the status quo – as in discussions of 'non-design' and (post-)critical architecture in the previous sections. Indeed, intellectual and ideological issues of criticality are present in interaction design – in 'critical technical practice' and as discussed in relation to contemporary tendencies of 'conceptual', 'concept', and 'critical' design. Moving beyond analytic or retrospective to transformative and projective modalities, post-critical proponents argue that the most effective critique is the interjection of 'physically perceptible and experiencable facts into the narrow margins of choice'. Critical practice might describe approaches to design that extend criticality through the materialization of provocative alternatives.

Change
Static!

In thus summing up some points from previous sections, certain issues come into focus. Given the power of design to effect change – in our individual relations to everyday things as well as societal behaviors and cultural trends – we must seek ways of taking responsibility for the design effects of technological objects by thinking and working critically from within – and by means of – practice. If we consider interaction design as having a profound role in changing people's ideas, lives, and cultures of use, as practitioners we must develop a basis for engaging with issues of ideology and responsibility with users, sponsors, and the public. Indeed, interaction design offers a rather particular possibility of enabling people to relate more deeply and in an ongoing manner to their own choices – and, by extension, those of society.

These were starting points for us in the design research program 'Static!', which focused on design for energy awareness. As the first research engagement between the Interactive Institute and the Swedish Energy Authority (STEM), it was a practical basis for developing a joint conversation and design space around certain relations among design, technology, and energy. Indeed, given the history of relations in the 20th century – in which the discipline of industrial design grew up around interest in increasing the profitability of the emerging electricity industry – it seems time to revisit such relations with respect to contemporary design, especially in relation to tendencies in sustainability and critical practice. In relation to STEM's scientific and innovation interests, our aim was to develop design concepts and theories, facilitating reflection upon energy issues in design and in everyday domestic use.

Static! was situated at a cross-section of diverse perspectives and concerns – including consumerism and ethics, global industry and private life, proximate use and social change, current behaviors and future effects, material culture and technological progress. In order to position research questions, it was necessary both to engage with the terms of various domains and respective stakeholders while leaving open-

ings for exploring emerging – and perhaps conflicting – perspectives. In practice, we considered project organization and research culture in relation to the parameters of the particular program and the specific domain. In theory, we were joining diverse concerns of design and research, sustainable and critical design.

Within the program, methodological experiments and design projects were the basis for negotiating interests, locating collaborative work, and developing concrete proposals. For example, a pre-start phase employed design methods such as 'cultural probes' and household interviews. This process catalyzed our internal research team and fueled our conversation with STEM as we developed our proposed research program. Resulting photographs, hand-written responses, and personal interactions were a basis in early workshops for rediscovery of the topic through others' eyes and in ordinary contexts of everyday energy use. These activities generated a collective curiosity and triggered an experimental attitude among diverse stakeholders, as well as providing information and inspiration for practical work.

Project work was anchored in several different approaches – including service and industrial design, conceptual and critical design. Some projects focused on visualization and efficiency, examining how design and technical systems might be better integrated to solve certain problems or expose choices such that users might become more empowered. Others materialized questions about the status quo, challenging relations between values of emotion, memory, and ethics and of functionality, efficiency, and persuasion. Still others provoked reflection on alternatives, mobilizing design methods and materials to situate a participatory discussion about possible futures. Diverse approaches staked out the rich spectrum of ideas, values, and stakeholders present in current debates about energy and within design.

Change
Static!

This section reflects upon our approach, contextualized within certain discussions from the previous sections. In addition, there are more personal and concrete afterthoughts on how issues of 'systems', 'alternatives', and 'operation' might relate to the 'Energy Curtain', 'Free Energy', and Front design projects.

Sustainability ≠ Criticality

On the surface, sustainable and critical design might seem to be at odds. Indeed, the concerns of 1960s ecological, organic, and pacifist movements were not necessarily congruent with those of contemporaneous radical and anti-design. There were diverse and conflicting interpretations of the causes of – and hence responses to – social change. Rather than generating utopic visions, for example, anti-designs were often dystopic. Even within current discussions of sustainable design, different valuations of technical, capital, ethical, and cultural factors produce divergent views of relations between technology and aesthetics, human agency and cultural context. [2] Where green and sustainable design may earnestly try to solve pressing, large-scale problems, conceptual and critical design embrace irony, complexity, and ambiguity for purposes of 'problem-finding'. However, sustainable and critical design intersect in contesting – rather than affirming or acquiescing to – mainstream consumption. Starting from this shared concern, a critical practice in interaction design might open for new insights and approaches with respect to sustainability.

Discussions of consumption often herald 'consumer democracy' – the power of which is certainly evident in the rise of 'green consumerism'. As Victor Margolin articulates, "users interact with the product milieu, supporting those products such as the VCR and the personal computer that are valuable to them and ignoring those that are not. They engage in a process of indirect negotiation with producers by deciding whether or not a product is worth sustaining." [3] Consumer democracy is premised on purchases, treated as economic 'votes'. However, studies of such consumption are narrow, as Peter Dobers and Lars Strannegård argue – "studies of sustainable consumption focus on the consumer and on consumption as bracketed in time and space: on the 'point of purchase'." [4] Focus on relations between sustainability and consumption in such terms – one vote, bracketed in time and space – posits a narrow scope for agency, both for designers and for potential users.

Reducing consumption to such terms evades more complex conceptions of lifestyles and ongoing lifeworlds. Design for point-of-purchase might easily be limited to what might be grasped directly and immediately, reduced to the visual qualities of form and packaging, rather than evolving values and choices involved in processes of use and interaction. There are some perspectives on consumption that have begun to take social processes and cultural values into account, considering aspects of meaning, well-being, and aesthetics. For example, conceived in terms of design aesthetics, consumption is increasingly treated as part of the ongoing construction of identity and lifestyle in the 'global image economy'. [5] For the most part, however, such approaches continue to treat design in terms of image and styling – often with a more or less hidden agenda of creating new markets and new products.

If sustainability requires us to consider 'progress' in terms of limits and complexity, rather than continuous expansion and quantitative growth, then we might rethink how we qualify and design for 'value' in design objects. [6] Besides market-value and point-of-purchase, Margolin shifts from what is bought, to what is used within the whole 'product milieu'. Primary market exchange does not account for secondary and tertiary markets, including things that are handmade, inherited, recycled, and exchanged within any range of (sub)cultural practices as discussed in 'Participatory practice'. Numerous purchase, interaction, and disposition processes may be combined in an object and associated processes of packaging, purveyance, and service, implicating additional ideological, economic, experiential, and cultural factors. Choosing among and living with products today involves a range of existential variables that play into the value – and thus long-term sustainability – of things in society.

This suggests a need for further enquiry into design objects as complex material and social constructions with respect to the endurance of things in everyday life. Certainly low-impact materials, planned obsolescence, and the 'disposable society' should be considered. These are often topics in sustainable product development in terms of physical or technical 'durability' – implications of which may be applied comprehensively into design and manufacture or merely for promotional or novelty value. However, the material and technical basis for production are only part of the whole picture, if we consider the total product milieu and societal sustainability. As Jonathan Bell argues, "More often than not, a product's 'life cycle' – that is to say the cradle-to-grave trajectory taken by an object from fabrication, through marketing, consumption, use, rejection, and eventual destruction, as opposed to the concept of 'life span', which only refers to the third and fourth of these stages – is defined not by its physical but social and technological durability." [7]

In addition to sustainable development and consumer research, design might open up for further speculation on and critique of conventional consumption. As Bell argues, "perhaps we need to think in terms of life cycle rather than life span, raising manufacturer and consumer awareness of the secret life of objects, composed from their various interactions." [8] He points to Dunne & Raby's insinuation of uncertainty and ambivalence into design objects, in which the intimate and cultural pathologies that emerge through use over time more closely resemble reality. In his account, sustainability engages with design explicitly in the subversive and critical terms that fall outside of conventional consumption. Conceptual, concept, and critical design offer strategies for probing into the ideologies objectified in things – making these more explicit in design and more available to reflection in use.

Change
Static!
Sustainability ≠ Criticality

Further, we might understand use as an ongoing achievement, as a form of 'active critical participation' involving commitment and agency in continually reinterpreting and appropriating things. Indeed, Cameron Tonkinwise argues, "It is the very finishedness of modern (un)made things, the way they are cast out into the world as from then on unchanging, that, far from granting them long lives, destines them to be a never finished stream of short use-life objects." [9] We need only look to urban design, domestic space, and technology, which may be characterized by more complex and ongoing relationships to things in use, such as retrofitting, appropriation, and hacking. Another way of enquiring into personal and social values in consumption might be to design objects that are open for change, to set the stage for other ways of (un)doing things. Rather than determinate or pre-determined form, such accounts argue on behalf of transformability and openness, strangeness and decay.

This suggests possibilities of an alternative 'aesthetics of use', enriching experiences of interaction and diversifying values of consumption. [10] For one, we might further explore the aesthetic strategies explored in conceptual, concept, and critical design. Through such investigation, we might become more precise about how to design for 'poetic'- or 'critical distance' between people and things, and how such distance might enable reflection or debate on sustainable ideas. Secondly, we might consider design for 'reflection in use' to move beyond the material, formal, and aesthetic limits of critical design. Outside the spatially and temporally limited point-of-purchase – or art gallery – most choices and transgressions with respect to consumption evolve in proximate use and as cultural phenomena. While we are only starting to investigate such issues, these frame our approach to thinking and making in Static!

The ethical and ideological debate on sustainability, which relates to large societal issues, is hard to articulate in relation to the local and proximate terms of everyday life. In Static!, we sought to move beyond the simplistic terms of – on/off, consume/

conserve, save/spend – to which such debate is typically reduced in marketing and information campaigns. We took product and interaction design to materialize energy – exploring the aesthetics of energy that might render it more visible and experiential in everyday life, and the proximate interactions that might become a basis for increased reflection and choice in energy use.

Working with energy not only from a technical but an aesthetic point of view, we explored energy as a sort of material. This idea formed a thematic common ground among competences and perspectives brought by diverse stakeholders, including textile design, industrial design, human-computer interaction, electrical engineering, and architecture. To complement and challenge more conventional focus on problem-solving, participatory and critical practices experimented with alternative aesthetic strategies. For example, the form and materials of familiar domestic objects were decomposed – literally and conceptually. Front design 'de-engineered' material surfaces, such that chemical or computational dynamics might reveal the presence of existing but invisible energy sources. Curtains, radios, lamps, cables, and radiators were reinterpreted, augmented, or redesigned in order materialize energy choices and patterns. Conceptual or concept designs explored 'alternative nows' and 'visions of the future' by means alternative 'aesthetics of use' intervened into the everyday.

By combining diverse disciplines and thus types of products, different scales of spatial and temporal form were engaged. For example, the longevity of technical devices could be juxtaposed with that of interior designs, the material presence of personal electronics overlaid with associated public services. Thus, we opened up for discussion about the valuation of technology and aesthetics, with respect to conventions of quality and functionality, taste and utility, evolution and meaning. Further, conceptual designs were deployed for testing in usability or domestication studies, as a basis for better understanding of how objects designed to create a certain 'critical distance' or 'resistance to assimilation' might meet actual reflection by critical subjects in use. Thus we might enquire into how such design might effect changes in perceptions of and relationships to energy through embodied action, habitual use, and household dynamics over time. In Static!, we considered energy not only in terms of utility and ease-of-use, but in terms of how 'reflection in use' might be prompted by the aesthetics of material interactions with the objects at hand in everyday life.

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The sustainability of everyday objects is determined not only by design but by use – as objects are lived and interacted with over time, and as awareness evolves within households, communities, and in (sub)cultures. Conceptual, concept, and critical design strategies focused not only on the material and aesthetic qualities of designed things, but on how spatial and temporal form might relate to more existential issues, such as the emotional, ethical, and social values embedded in material and technical systems. Shifting perspective enabled us to speculate further, on how 'reflection in use' might also effect societal visions and change – by means of participatory and critical practices. While carefully crafting visual, tangible, and experiential qualities, our intent was to materialize relations to energy such that they might be reflected upon, within design processes, in actual use, and in the public arena.

'Object as discourse'

Objects may be understood as forms of discourse in various ways, as explored more extensively in other sections of this text. As 'persuasive arguments', for example, Richard Buchanan understands design objects as forms of rhetoric, communicating information and mediating agency from designers to users. For Bruno Latour, objects are issues, generating emotions, disruptions, and disagreements, assembling together a variety of intentions and interests and, through materialization, provoking

new occasions for debate and dispute. In this way, all objects might be seen not only as political but as mapping out another 'public space' embedded in the most intimate and private aspects of everyday life. To Michel Foucault, objects might be considered as 'statements', to Stan Allen, 'forceful propositions.' As arguments, assemblages, statements, or propositions, objects are understood to embody and impart ideas. [11]

In critical design, the designed object might be understood as a sort of materialized form of discourse. In Anthony Dunne's case, "the electronic objects produced in the studio section of his doctorate are still 'design,' but in the sense of a 'material thesis' in which the object itself becomes a physical critique... research is interpreted as 'conceptual modeling' involving a critique of existing approaches to production/consumption communicated through highly considered artifacts." [12] This differs from some approaches to practice-led research, in which the design process is equated with a research process. As a form of socio-aesthetic research, design making, in this case, is directed at materializing and situating aesthetic and critical theories. Through form, ideas become available to the terms of art criticism, design theory, and technology research – and potentially for public and everyday consumption.

Similarly stating, "Designs can be seen as embodiments of beliefs or theories about the myriad of issues relevant to them," William Gaver argues, "But in embodying beliefs and theories in an integrated design, designers can be seen as researchers, asserting hypotheses and theories that will be tested aesthetically rather than empirically." [13] The products of design are generally intended for others than the designer, with effects that extend after the design process and beyond the object itself. Gaver argues that the value of design products is mediated by the marketplace, where designs must thus "speak for themselves". While the products of design research or critical practice might not be destined for the consumer market, even contesting notions of consumption and value, they may 'speak' in different ways to different audiences, ranging from peers and stakeholders, to users and the public.

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Any notion of the 'object as text' or as 'idea/text', resonant in ideas of critique and criticism drawn from art history or linguistic theory, may not fully account for the conditions of design and use. Certainly, the difficult forms of 'critical architecture' might intend to force a hermeneutic reading of their own (de)construction – the architect quite literally situated as author, the inhabitant as reader. However, a much different story might be told after changes in inhabitation and property value, in taste and criticism. As any range of postmodern and post-critical revisions suggest, architecture is not writing, nor are spatial practices discursive. [14] There is no transparent 'ideological transfer' between reading and writing, production and consumption, design and use. In between, as phenomenological and sociological accounts argue, any range of interpretive, experiential, social, and cultural factors intervene.

Indeed, critical architecture tended to equate aesthetic critique with political critique in ways that simply do not account for change, whether in proximate use or societal trends. As forms of ideological discourse, design objects may certainly take on roles that are demonstrative, informative, persuasive, authoritative, and propositional. However, design moves beyond political rhetoric through engagement of material form, everyday utility, and ongoing interaction. Indeed, while it is often lamented that radicalism is all to easily appropriated into embodied habit or mainstream convention, this might be its most powerful role – to realize behavioral transformation and cultural change. While we must certainly gain a better understanding of relations between ideology and design – for example, by means of ontological, hermeneutic, or even ergonomic analysis – perhaps the real potential of 'critique from within' any 'material practice' is to open up a more experiential and participatory space for enquiry. [15]

Just as design does not involve any absolute determination or unequivocal translation of ideas into form, nor does use merely involve efficient translation of or compliance to such ideas. Indeed, perhaps the most interesting problems arise as critical designs meet critical subjects. This is precisely the tension between an 'aesthetics of use' and 'reflection in use' that we wanted to explore in Static!

In the section on 'Critical practice', various approaches to such dynamics were discussed in terms of 'resistance to assimilation'. In (post-)critical architecture, this might involve strategies of defamiliarization and estrangement to prevent unthinking incorporation into bodily habit or cultural norm. Through material selection and formal composition, the objects of critical design and architecture attempt to interject a 'poetic'- or 'critical distance' between designed objects and those who view or use them. In Static!, the Energy Curtain, Free Energy, and Front design examples experimented with the temporal and spatial form of interactions with energy, with ongoing and habitual use, shock and provocation, adaptation and decay. Taken together, the projects map out a range of alternative aesthetics of energy use.

In Static!, aesthetics were a basis for critical reflection, alternative choices, and behaviors emerging in use. As Dunne expresses a desire to move past modernist dialectics – "To provide conditions where users can be provoked to reflect on their everyday experience of electronic objects, it is necessary to go beyond forms of estrangement grounded in the visual and instead explore the 'aesthetics of use' grounded in functionality, turning to a form of strangeness that lends the object a purposefulness." [16] While 'resistance to assimilation' might be rather designed into aesthetics and interactions, in Static! this should direct attention to ideas, values, and choices made in energy use. Rather than the dialectics that still resonate in post-critical stances, we were interested in diversifying and intensifying the space between anti/utility [17] – as 'strangely familiar' designs might situate a give-and-take between critical ideas explored in design and those engaged in use.

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For us, it was precisely utility – proximate interactions and everyday experience – that provided a site for enquiry where technical, aesthetic, and behavioral concerns might intersect. Indeed, the tension between 'aesthetics of use' and 'reflection in use' exposes a range of overlapping theoretical, methodological, and operational concerns binding together production and consumption by means of the spatial and temporal forms between. We might start to wonder, for example, about potential relations between the 'reified object', typically in focus in art criticism and design history, and the 'deified subject', as might characterize some phenomenological and sociological perspectives. A notion of the 'object as discourse' might locate an intersection among research concerns in diverse fields – where critical design practice effects evolving material culture, where phenomenal experience might meet critical reflection, where the design of interactions might effect behavioral transformation.

Reflections on critical practice

Three issues were drawn out in 'Critical practice' to frame the problematics discussed in 'Design effects' – 'systems', 'alternatives', and 'operation'. These are extended here to loosely frame some reflections on 'Energy Curtain', 'Free Energy', and Front design projects. This is done retrospectively, of course, upon a program and projects with particular concerns and conditions that circumscribed their original conception and progress. Thus, reflections are exposed as afterthoughts and speculations that are left open-ended, which may resonate with topics discussed in other sections of this text or as threads for future development.

Systems

Energy use involves complex relations between private and public interests. Economics and environment, local and global, present and future – such concerns are bound into energy use. How these are connected to one another, and to objects and interactions in everyday domestic life, may not always be apparent. Energy may easily be taken for granted or perceived as an abstract issue. Even the physical infrastructures supplying energy and other services, while ubiquitous and essential, are typically hidden inside walls or shut away out of sight. In treating the awareness and use of energy as central to design, working from the status quo not only means rethinking existing relations to material and technical systems in use, but also how intervention into such relations might, in turn, effect systemic conditions.

In conceptual, concept, and critical design, as discussed, there are diverse strategies for intervening into the status quo. For example, mundane norms might be made explicit or amplified, to situate formal transgressions or future alternatives. Or, the everyday, conceived as made up of continual choices and adaptation by social actors, might be a stage for situating such agency. In both cases, convention is made use of, put more or less in the foreground, in order to expose relations, even conflicts, between consumption and citizenship. In Static!, such approaches were employed to shift attention to the presence and use of energy everyday life.

Free Energy explores the interplay of private/public, personal/community, local/global within objects and interactions. The Energy Tap is an open object – energy is free, available anytime and anywhere. While energy typically originates in distant power plants and energy outlets restricted to private spaces, the Tap relocates energy generation and access. Generation requires personal and physical effort, energy is a local product and resource. Energy use becomes a public spectacle – tea parties and mobile offices might cross into public space. Another example, the Kinetic Door, parasites on existing things (revolving doors) and mundane effort (pushing the door). Between the building and the street, the object is sited at the boundary of public and private space, where personal choices directly affect environmental conditions. A simple intervention, the object siphons personal effort into a visible reward. The Free Energy project employs concept design, intervention art, and activism to rethink the balance of between access and control, effort and effect.

The Energy Curtain embodies and complicates the trade-off of conserve/consume. Extending beyond a rhetorical question, the Curtain is a useful and desirable product. While operating conceptually, the engineering and aesthetic integration of fiberoptics, LEDs, and solar cells were carefully considered. Early prototype weaves were handicraft, but subsequent versions were based on the existing product line and made on industrial machinery at the textile manufacturer Ludvig Svensson. Proposals for more comprehensive solutions were drawn up and priced together with partners. In this case, aesthetic desirability, existing markets, and material construction were deep-

ly engaged – with the prospect that a self-sustaining conceptual design might be feasibly integrated into ordinary domestic life. Habitual interaction with a familiar object might thus effect enduring conceptual relations to product and energy use.

These projects within Static! relate to the systemic conditions that circumscribe energy consumption in various ways. Each attempts to materialize such conditions through conceptual or concept designs – where the Front design projects expose the spatial and temporal expressions of energy in use, Free Energy constructs functioning props for public use and debate. The Front designs and Free Energy prototypes expose natural energy sources and public services that are typically invisible and often hidden away. Rather than drawing attention to the interpenetration of public, private, and natural energy sources, the Energy Curtain is a self-sustaining object. In this project, it is the material and technical systems of design manufacture and production that are reinterpreted. Thus, in very diverse ways, the overlapping terms of public and private, local and industrial, production and consumption are queried and materialized back into the ordinary surround of everyday life.

Afterthoughts

There were a wide variety of project outcomes in Static! – of which these are just three. Projects work developed on very different levels – as concept illustrations, as feasible product designs, as conversation starters, as experimental designs – the way in which the various objects should be understood and communicated may not be self-evident. The value of some might be more instantly and conventionally apparent – for example, as useful or attractive objects appealing to innovation, commercial, or media interests. However others were more directed towards methodological or theoretical issues that required a certain context to understand and communicate.

In retrospect, it proves difficult to find a basis for common reflection and valuation within the program as a whole, except in terms of general starting themes or intentions. While 'problem-solving' might be easily understood and communicated, 'problem-finding' by unconventional means proved much more difficult to situate. We tend to gloss over the projects that are difficult to explain with respect to the context at hand – it is difficult to tell if this is because important conflicts have been exposed or whether we simply lacked time at the end to reflect upon the program as a whole. While general notions of visualization and materialization, awareness and reflection, might well describe our starting points in the program, perhaps we need another basis for analyzing and reflecting on the results.

One way of understanding the territory is by mapping the extremes – for example, of alternatives to the status quo or 'aesthetics of use' of energy consumption. In such terms, we might even find real extremes lacking – aesthetics might be further pushed to the limits of parody, as 'taste' and 'good design' might be opposed by kitsch and anti-utility in conceptual design. Or, the act and effect of use might be pushed farther, as extreme effort mobilized to use design objects, or amplified local and public effects. In fact, such ideas were explored early on, concurrent with the cultural probes and household studies, though not present in the program or even the memories of us participating as much as they might be. Those taken forward worked in more subtle ways to complicate the idea and act of energy consumption – avoiding shock tactics, this allowed us to explore aspects of use in much more depth.

In challenging any convention or mainstream, mapping the extremes helps to situate choices. The context of criticality in design provides one context for valuation in this case. Indeed, Static! in this context might be understood to systematically probe the space between anti/utility discussed in 'critical practice' – or perhaps (un)ease-in-use

Speculations
How might objects, or systems of objects, situate connectivity between local action and large-scale or long-term effects?

How to situate the objects resulting from these projects as products of design research, rather than as 'design products'?

Do – or should – such products 'speak for themselves'?

How might phenomenal concerns for experience and critical concerns for ideology meet – in theory, in practice, in use? How might 'reified objects' and 'deified subjects' intersect?

How might strategies of 'problem-finding' be valued or evaluated outside of design or research?

in the terms of HCI. This opens up for relations to research issues touched upon in 'Becoming users' – that is to say, how aesthetics and interactions move things between being 'present'- to 'ready-at-hand' in embodied use. [18] Indeed, conceptual, concept, and critical design might be considered as strategies for intervening 'breakdowns' into the unthinking incorporation of things into the status quo or mundane routine – strategies for making things more 'resistant to assimilation'. This opens up a rich space for locating our own reflections, and even situating evaluations, in relation to design history and research issues in interaction design.

Alternatives

A focus on everyday things and domestic life shifts attention to quite intimate as well as quite mundane forms of engagement. As the cultural probes and household interviews revealed, energy use in everyday life is closely tied to emotions, meanings, and rituals of family life, to daily, seasonal, and holiday cycles. Rather than devaluing such associations by asserting the authority of a new or opposing set of values, we tried instead to expose existing values, to reveal the choices and agency already embedded in everyday things. Approaching this through design meant that we materialized alternative ideas into familiar forms, habitual actions, and everyday activities. By such means, we were interested in how design might open up and construct questions, invite reflection, and alternative forms of engagement in energy issues.

In order to develop relationships with energy in and through objects that were already familiar and meaningful, we started off exploring reflections on such everyday things. Responses collected from the probes and interviews featured a range of things and behaviors: for example, curtains, lamps, wallpaper, electrical sockets, plumbing fixtures, consumer appliances, and; drawing the curtains, turning things on and off, taking a shower, paying bills. From such starting points, we considered how to shift energy both conceptually and materially into focus in form and use. For example, Front design explored one-off and long-term choices. Simple, perhaps even unthinking agency involved in selecting a lightbulb or wallpaper is amplified – instantly (the Heat Sensitive Lamp) or over years (Appearing Pattern Wallpaper). In each, energy is involved in formation – as a basic material in building form – with different spatial and temporal expressions brought into focus by design.

In the Energy Curtain, control over the spatial and temporal presence of energy is placed, literally, in the hands of a user. Rather than typical 'on/off' interactions with energy perceived to be ubiquitously 'on tap', the Curtain requires repeated choices to be made daily and in advance of enjoying the aesthetic effects. The daily routine of opening and closing curtains is repurposed as basic control over the energy cycle of the self-sustaining object. Amplifying cycles in nature and in domestic life, the Curtain renders one dependant on the other – sunlight may be transposed into the evening, but only through explicit choice and action. Thus, the paradigmatic trade-off between conservation and consumption is materialized locally and tangibly, as the conceptual and interaction principle of a familiar object. This suggests that existing behaviors might be understood as active choices, even the most basic interactions as forms of 'active critical participation'.

Interaction design in particular deals with ongoing choices directly in and through an energy-consuming product. While the Energy Curtain is a technological object sustained locally and personally through a user's actions, the Flower Lamp operates in relation to larger energy infrastructures. The Lamp's form reflects data collected by remote-monitoring technology connecting households directly to the power supply company. Individual choices count, as do choices made repeatedly and within the household as a whole. The domestic energy use is present in the family room

– as the Lamp's ongoing aesthetic (de)formation. Energy behavior is available to the whole family – change must thus be continually and collectively negotiated.

These projects delve into the detailed material and social construction of everyday domestic life, experimenting with the insinuation of alternatives through form and interaction. Design reinterprets the everyday – through ordinary objects, norms of aesthetics and production, and sequence and flow of habitual action. As a material, energy literally builds the spatial and temporal expressions of objects in use.

Afterthoughts

As an exposure or insinuation of alternatives, rather than the shock tactics of disjuncture or negation, Static! explores 'aesthetics of use' and how alternatives might effect 'reflection in use'. Indeed, the aesthetics of several projects depend upon actions and interactions in use. The Energy Curtain, for example, not only takes care in crafting energy as, literally, a technical and aesthetic material, but it requires interaction to perpetuate the cycle of energy collection, storage, and display in the self-sustaining object. Thus, such objects moved beyond the reactivity or autonomy of 'ambient displays', as explored in HCI, since they are premised on an interdependence between aesthetic formation and committed interaction, such that the object might be sustained by use over time.

In this case, critical practice could not be just about 'problem-finding' for its own sake, but about enquiry as to how questions might be opened up for reflection – as well as debate and choice – in use. This is precisely the difference discussed between past conceptions of criticality in design and notions of 'criticism from within' – in which practice differs from discourse in conceptually and literally ' constructing doubt'. Through the materialization of 'physically perceptible and experiencable facts', built and used things inevitably depart from the status quo, thereby effecting some sort of behavioral transformation. This means that we cannot only enquire into the conditions for design – the systems that circumscribe practice and the aesthetic logics that constitute form – but we must consider how critical practice and alternative aesthetics condition use.

Questions of behavioral transformation engage research issues beyond those typically involved in conceptual, concept, and critical design. How design conditions use is a complex question that might be treated in terms of psychology, behavioral science, sociology, or material culture. Further, we were interested not in general issues, but how ideas and agency with respect to energy issues are materialized and subsequently effect changes in energy behaviors. Originally, Static! was set up to deal with such questions by dividing the research into two parallel tracks, one focused on design, the other on behavior, with phases of convergence every three months where discussion and exchange of ideas and prototypes might occur. Ultimately, however, since the behavioral track instead developed to be more design-oriented, a far more diverse range of design approaches were developed – leaving us, however, without an integrated behavioral perspective.

Even beyond problems in the operation of the program, there are other problematics involved with respect to behavioral research. For example, we were designing not only spatial but temporal aesthetics, with reactive and interactive expressions that might change continually, even over years. Besides behavioral factors that might be studied in the here and now – for example, within the contained contexts and time-constraints of typical product evaluation – there is a range of questions about projections and transformations of future use, the social and cultural context of which we cannot fully determine nor predict. To a limited extent, we have explored such issues

Speculations
How should attention, action and interaction related when it comes to designing for reflection?

How do (alternative) aesthetics and 'critical practice' condition use?

Do 'critical designs' produce more than ordinarily critical subjects? Critical of what?

Do critical designs remain critical over long-term use? How might assimilation – or domestication – change resistance over (a long) time?

How do 'temporal form' and 'use as participation' effect change in behavior? Processes of assimilation or domestication?

through a partnership with the University of Art and Design in Helsinki, within a study on the 'domestication' of the Energy Curtain and another Static! project called the 'Erratic Radio', installed in households over several months. [19]

The idea of behavioral transformation, like design in general, involves future projection. Indeed, the kinds of long-term societal changes that we would like to effect might better resonate with notions of 'futurology', 'futures', and 'foresight' more familiar in the domains of business, economics, and politics, as discussed in the section on 'Becoming users'. This is precisely the challenge of the post-critical move from the ontological to the political – a shift away from merely accounting for what is, what we already know, and what we might predict and project. Any 'critique from within' not only has to acknowledge the limits of the knowledge proper to its domain, but, as conceptual, concept, and critical design do, venture into unknown and even unknowable questions.

Operation

Static! explored ways of exposing choices, alternatives, and consequences through design – in other words, possible conditions for critical reflection in use. In reality, however, change in energy awareness and behaviors on a significant scale happen over long periods of time and on a societal basis. Everyday things such as domestic interiors or appliances have varied lifespans and incremental turnover in households. Such things are domesticated or appropriated meaningfully into lifeworlds only over time. Moving from the status quo to real change by means of design is clearly beyond the scope of the design process or even discrete design products. Within the scope of the design research program, we nonetheless had to operate in relation to notions of extended use and behavioral change. While traditional research methods of analysis and evaluation have been valuable, we were explicitly concerned with projection into contexts and cultures of future use.

In order to explore such issues in project work and open up for wider debate, we drew on alternative strategies for ideological production from conceptual, concept, and critical design. For example, 'underdesigned' one-offs and 'paper architecture' may evade or critique conventional modes of product design production and consumption. Concept designs shift attention from problem-solving to future projection, sparking wider debate and building shared commitments. Involving such strategies, mixed in with others more established in design and research, helped expand ideas as to value, (e)valuation, and validation. 'Reflection in use' was taken literally – as reflection by users on and through their own consumption, interaction, and choices – as well as rhetorically – as the situation of ideas for 'consumption' within wider public, institutional, and cultural contexts.

For example, we employed alternative methods for deploying ideas and participatory projection in Free Energy. Interventions of the Energy Tap were staged in public – to test emerging behaviors and uses, a functional prototype was installed, which also acted as a conceptual prop for staging a local debate. The Kinetic Door, surreptitiously installed in privately-owned buildings, siphoned off personal effort for public effect, prompting ethical speculation about design and energy. While public service infrastructures ubiquitously infiltrate the walls and basements of private homes, the very idea of 'free' energy, as well as materialized prototypes where alternatives might be tried, opened for discussions of ownership and agency, and for speculation and new behaviors to emerge in situ.

Collaborating with Front design engaged another dimension of discourse. In addition to competence from product design and engineering, and established structures for

research and validation, Front provoked a range of alternative insights on technology and energy. In their projects, technology was peripheral, perhaps not even involved at all, and other effects such as chance, rituals, time, and nature were explored. Their own interest in the everyday touches on the anthropological and ethnographic, but veers quickly into experiments in form and material. The craft and culture of design is basic to their practice – for example, as pertains to the aesthetics and material culture of a socially-loaded object such as a chandelier. While we might speculate on such aspects from a research perspective, their experience and perspective on the design field lifted the question to another level and to particular audiences.

Afterthoughts

In Static!, we employed design and research strategies atypical to the energy sector. Disparate perspectives illuminated complex and overlapping material, social, and technical concerns. In addition to internal discussions, external collaboration enabled concerns to be more deeply and concretely developed. Working with Front expanded our horizons, for example, and Ludvig Svensson allowed us to realize both conceptual and industrial versions of the Energy Curtain. Overall, the 'products' of design research were extended in various ways – into industrial manufacture, social science evaluation, mass-media publicity, and museum exhibition. While it is perhaps difficulty to contextualize the value of all the examples, for all the audiences, all the time, the program situated conceptual designs and 'objects as discourse' alongside more traditional approaches, thus provoking new conversations.

For example, extending the Energy Curtain as a conceptual design both into industrial manufacture and in-depth sociological study prompted discussions about where the line between resistance and assimilation lies. Further leveraging the projective and rhetorical aspects, projects such as Free Energy quite deliberately stepped into the realm of political and public opinion. As an entire program, Static! was also presented within industrial and political contexts – from the Wired Magazine NextFest to the Swedish National Energy Convention. For in-depth discussion of overlapping issues in product design, technology research, and sustainable development, we launched an Energy+Design network as a series of public forums attended by industrial, political and academic stakeholders, with Static! projects to ground and provoke debate. Multi-disciplinarity and collaborative work raised more questions than were answered – exposing further issues of design in research and research by design.

Since Static! focused on staking out multiple directions in a space for future design research in and around concerns of energy use, perhaps the greatest potential is in identifying particular questions for further expansion. For example, given an understanding of historical and political implications of criticality in design, we might probe more specifically into differences between post/critical perspectives. There remains a need to develop agendas for critical practice in interaction design that do not go to the 'post-ethical' and 'post-moral' extremes of post-criticality, nor retreat formalist or pragmatist extremes while 'waiting for the revolution', but challenge notions of design merely 'in service' to set ideologies and technology as merely instrumental or neutral. Or, we might enquire more deeply into the systemic conditions of design and use, since energy provides an interesting example of overlapping public/private, local/global, object/network systems – perhaps a basis for future investigations.

Speculations

How to consider the role of craft and form in the context of 'ideological production'?

How might objects need to be crafted differently in order to effect different types of consumption? How – or should – a critical design be altered in order to operate in a commercial, artistic, media or other context?

How to combine different disciplinary perspectives in such a program? How to relate to differences in ideological context and critical concerns of various stakeholders?

Is there a need to be more precise about differences between technical, aesthetic, and political concerns within a notion of 'critical practice'?

How do – or are – specific ethical, moral, or political interests situate 'critical practice'?

Notes

1 For some background to research issues informing Static! see Mazé and Redström, "Difficult Forms: Critical Practices," *Proceedings of IASDR*; Redström, "En Experimenterande Designforskning," in *Under Ytan*, ed. Ilstedt Hjelm; Redström, "On Technology as Material in Design," *Design Philosophy Papers;* Redström, "Persuasive Design: Fringes and Foundations," *Proceedings of PERSUASIVE*; Routarinne and Redström, "Domestication as Design Intervention," *Proceedings of NORDES*.
For an overview of the program set-up and projects see Static! (website); Backlund, Gustafsson, Gyllenswärd, Ilstedt-Hjelm, Mazé, and Redström, "Static! The Aesthetics of Energy," *Proceedings of Wonderground*; Ilstedt Hjelm, "Energi som Syns," in *Under Ytan*, ed. Ilstedt Hjelm; Mazé, "Joining Tradition and Innovation," *Proceedings of ERA*.
For further information on the projects presented here see Danielsson, "3 Steg för Nytt Stadsliv" (MA thesis); Ernevi, Jacobs, Mazé, Müller, Redström, and Worbin, "Ambience for Energy Awareness," in *Proceedings of Ambience*; Ernevi, Jacobs, Mazé, Müller, Redström, and Worbin, "The Energy Curtain," in *IT+Textiles*, ed. Redström, Redström, and Mazé; Jacobs, and Löfgren, "Promoting Energy Awareness," *Proceedings of NORDES*; Jacobs, Löfgren, and Mazé, "Free Energy: Alternative Designs," *Proceedings of CUMULUS*; Müller, "Energy Curtain," (MSc thesis).

2 For an overview of such issues see, for example, Guy and Farmer, "Reinterpreting Sustainable Architecture," *Journal of Architectural Education*.
For more about anti-design see sections 'Design effects' and 'Critical practice'.

3 Margolin, "The Product Milieu and Social Action," in *Discovering Design,* ed. Buchanan and Margolin, 138.

4 Dobers and Strannegård, "Design, Lifestyles and Sustainability," *Business Strategy and Environment*, 14. For a comprehensive study and argument for differences between consumption and acquisition and sustainable use see Shove, *Comfort, Cleanliness, and Convenience*.

5 See Dobers and Strannegård, "Sustainability"; Mau, *Life Style*.

6 See, for example, Margolin, "Expansion or Sustainability: Two Models," *Politics of the Artificial*; Manzini, "Prometheus of the Everyday," in *Discovering Design*, ed. Buchanan and Margolin. For a perspective on value given technology trends see Goulden, Mavrommati, and Munro, "Sustainable 'Disappearing Computer' Artifacts," *Convivio Web-zine*.

7 Bell, "Ruins, Recycling, Smart Buildings," in *Strangely Familiar*, ed. Blauvelt, 72. For a related perspective on the social sustainability of things see Walker, "Object Lessons: Enduring Artifacts," *Design Issues*.

8 Bell, "Ruins," 72.

9 Tonkinwise, "Is Design Finished?" in *Design Philosophy Papers*, ed. Willis, 25. See also, Rendell, "Doing it, (Un)Doing it," in *Occupying Architecture*, ed. Hill.

10 For background to issues relating to 'aesthetics of use' and 'reflection in use' see Dunne, *Hertzian Tales: Electronic Products*; Graves Petersen, Sejer Iversen, Gall Krogh, and Ludvigsen, "Aesthetic Interaction," *Proceedings of DIS;* Hallnäs and Redström, *Interaction Design: Foundations, Experiments*; Redström, "Aesthetic Concerns," in *Pervasive Information Systems*, ed. Kourouthanassis and Giaglis; Redström, "Designing Everyday Computational Things" (PhD diss.).

11 See Buchanan, "Declaration by Design: Rhetoric, Argument," in *Design Discourse*, ed. Margolin; Latour, *Pandora's Hope*; Latour and Weibel, eds., *Making Things Public*; Foucault, *Archeology of Knowledge*; Allen, "Its Exercise," *Columbia Documents*.

12 Seago and Dunne, "New Methodologies in Art and Design Research," *Design Issues*, 16-17.

13 Gaver, *Presence Project,* 202-3.

14 See Allen, "Its Exercise"; Allen, *Practice: Architecture, Technique and Representation*; Hatton, "Exploring Architecture as a Critical Act," *Architectural Research Quarterly*. For examples of (post-)critical architecture see the section 'Critical Practice'.

15 For related arguments see Allen, "Dazed and Confused," *Assemblage*; McLeod, "Architecture and Politics" (*Assemblage*, 1989), reprinted in *Architecture/Theory/since 1968*, ed. Hays; Silvetti, "The Beauty of Shadows," *Oppositions*; De Carlo, "Il pubblico dell'architettura" (*Parametro 5*, 1970), reprinted in *Architecture and Participation*, ed. Blundell Jones, Petrescu, and Till; Winner, "Political Ergonomics," in *Discovering Design,* ed. Buchanan and Margolin. For futher background, refer to the sections on 'Design effects' and 'Critical practice'.

16 See Dunne, *Hertzian*, 42.

17 See, for example, the discussion in Betsky, Hays, and Anderson, *Scanning: The Aberrant Architectures*.

18 For a related argument and discussion see Verbeek and Kockelkoren, "The Things that Matter," *Design Issues*.

19 See Routarinne and Redström, "Domestication".

Recap

An enquiry into time – essential, I argue, to an understanding of the relations between design and technology in terms of the form of interaction – has been developed here in terms of 'Materials', 'Use', and 'Change'. The argument within each theme proceeds conceptually, practically, and by example – an enquiry, roughly speaking, 'into', 'for', and 'through' interaction design. As a wide territory constituting my current understanding and experience of interaction design, this text, on one hand, enables me to more precisely locate my own work within a more expanded field, along with some respective reflections, conclusions, and critique along the way. On the other hand, the territory mapped out and built up in this text will undoubtedly be a basis for my future work in research and design. Rather than a conventional conclusions section, thus, this 'Recap' section recaptures certain key ideas, problems, and potentials.

While perhaps less pronounced, there are also certain transverse relations across the thematic framework – that is to say, across theories, practices, and programs – that are also worth mentioning first.

In expanding the scale and scope of consideration beyond proximate use, in 'Material life', 'Becoming users', and 'Design effects', I have drawn on disparate sets of ideas. A more typical approach is to define, apply, and develop a more specific set of philosophical ideas, for example from phenomenology or social constructionism – indeed, it might be possible to trace a certain 'history of ideas' through human-computer interaction in such terms. Since neither a deep analysis of philosophical foundations nor any comprehensive theory have been in focus here, there are likely missing and misaligned concepts. Indeed, in operating across multiple scales, themes, and disciplines, here, diverse ideas have been raised – even played off one another – to illustrate certain conflicts, limits, or gaps. Further, some concepts have also been inserted into such spots – 'becoming', 'in the making', and 'futurity', for example. For my own purposes, 'temporal form', the 'form of interaction', and 'future use' represent an attempt to grasp certain, perhaps competing, ideas in phrases that might provoke and open up for further discussion.

'Material practice', 'Participatory practice', and 'Critical practice' situate concepts in a more historical and practical context. These, however, should be regarded as provisional, rather than as categorical terms or disciplinary substitutes. In fact, it is not only the common ground, but uneasy differences, that are most revealing. 'Material practice', on one hand, locates a common operational approach and even a shared critical, devious, or divergent attitude to institutionalized knowledge, skill, and production across diverse traditions. On the other hand, the collection of tendencies within 'Critical practice' stand on very different historical, theoretical, and socio-economic grounds. While architecture seeks to escape the rigorous and restrictive distinctions of past conceptions of criticality, product and interaction design are only beginning to feel out intellectual and ideological underpinnings. Within a more general notion of 'critical practice', these contrasting currents expose values behind different orientations, as well as diversifying the range of possible strategies and tactics.

Lastly, many reflections on projects and programs have been sprinkled throughout this text. In addition to problematics raised in relation to theories and practices, these sections contain some of the most specific questions and starting points for further work. A selection of speculations on the 'IT+Textiles', 'Public Play Spaces', and 'Static!' programs finish off – by opening up – the recap of 'Materials', 'Use', and 'Change' to follow here.

Materials

As post-industrial technologies become pervasive in 'Material life', we must rethink conceptions of materiality in design. The complexity of mechanical technologies tended to correspond directly, or at least proportionally, to spatial scale. However, the size, shape, or scale of a computational object may not reflect what it does or how it works – breaking with design paradigms such as 'truth to materials' and 'form follows function'. Certainly, computers are materially instantiated – as electronic components and user interface – but increasingly complex, rapid, and extensive processes of computation intervene between. One design response has been to treat material form as symbolic or representational – rather than as a transparent expression or direct result – of the inner workings of a technological object. However, the application of additional 'product languages' to surfaces and interfaces is problematic with the miniaturization of form factors and shrinking 'screen real estate'. Just as we can no longer judge by appearances, perhaps we can no longer merely design surfaces.

Indeed, materials in themselves are increasingly in focus in intersections between computer and materials science. Even the most traditional of materials are characterized by emergent and dynamic chemical and mechanical properties – and computation integrated into new materials effects active and even interactive performances over time. In such terms, materials are not merely representative of something else, nor are technologies merely something to be packaged, but each is understood in terms of respective properties and potential performances. Indeed, technology might be understood quite literally as 'material', both conceptually and concretely, for building form both in space – and over time. The material conditions of technological objects might be, thus, considered not in terms of problematics of (im)materiality or (dis)appearance in spatial terms, but in terms of 'temporal form'.

Recap

Casting another light on tendencies toward the 'disappearing computer', this also resonates with reconsideration of 'form' in design. Instead of the object fixation and spatial preoccupation of 'formalism', contemporary revisions emphasize subjective, relative, – and dynamic – conceptions. Indeed, architectural discourse deals with both spatial and temporal (de)composition. Accounts of 'event', 'performance', and 'infrastructure' explore form as an intersection of 'social praxis' and 'spatial syntax', which catalyze new narrative, social, and psychic events that alter future possibilities. Performance, in phenomenal terms, gives primacy to the temporal order of personal and (sub)cultural practices and, in infrastructural terms, to gradients of intensity and difference, overlaps and synergy, exchange and evolution. Proponents examine, one hand, how space might be erased, reprogrammed, or transformed in time and, on the other hand, how form might condition (inter)actions and future eventualities.

Thus, we might consider the materiality of contemporary design, and of interaction design in particular, in terms of various traditional and new materials, including mechanical and computational technologies, which interact at nano-, micro-, macro, – and global – scales. From the scale of 'atoms and bits', to that of architecture and urbanism, form is built up out of disparate materials with performances that emerge, change, and evolve. Returning to basic definitions of form, we might consider the composite materiality of technological objects in terms of formation over time – by nature, by design, and in use. Rather than conceiving the object of design to be the result of a progression towards an ideal state or final order, design might be understood as conditioning spatial and temporal relations, situating the material conditions for interactions and events to happen along the unfolding of diverse processes. 'Temporal form' does not determine, or even predict, but describes how some 'thing' comes to be – or 'becomes' – out of various material conditions.

Revised conceptions of materiality imply a need to reconsider 'Material practice'. Indeed, a common supposition in moving to a more technology-oriented practice is the impoverishment of material traditions. The increasing complexity and industrialization of design has meant that technical specification and formal representation have taken precedence over direct and hands-on relations to materials. Responses to related issues in systems and software development have drawn attention to materials and making in design work. A discussion of 'design materials', for example, explores the role of material artifacts in design methods and collaborative work, and 'computing as craft' explores the computational tools by means of which designers conceive and produce form. Nevertheless, traditional and technological materials tend to be seen as something through which to do something else, rather than as possessing distinct properties that might be crafted in a material way.

Interaction design combines 'old' and 'new', 'low-' and 'high-tech' materials. Beyond general concerns for 'design materials' or 'computing as craft', we might locate a more fundamental basis for working with such materials in interaction design. For one, we might examine the material properties particular to post-industrial technologies. Treating 'technology as material', for example, puts the 'temporal form' of (inter) active material performance into focus. Further, since interaction design involves traditional and technological materials, we must relate to existing material traditions and techniques. Interaction design must take root in traditions of the 'artist-designer' and 'engineer-designer' without reverting to entirely nostalgic notions of craft nor merely instrumental notions of technology. Indeed, we might relate to a general renewal of interest in 'experimentation in contact with the real' in histories of 'minor science' and 'bricolage' within contemporary crafts, engineering, and architecture.

Recap

Indeed, increasingly affordable and accessible technologies are rapidly appropriated into the applied arts. Based on a tradition of material 'expressionism', practitioners investigate technical materials ranging from concrete and plywood to computation and biotechnology. Proponents of Do-It-Yourself ('D.I.Y.') excavate the cultural and industrial heritage of materials, mixing these up with technologies for aesthetic and critical purposes. As a technique and a process, 'weaving' incorporates diverse materials and material logics. These tendencies illustrate that material practice is not a matter of choice between craft or technology. Handicraft and readymades, algorithmic and meta-design, tinkering and hacking – the palette of methods is rapidly expanding. Technology is explored in very material ways – mechanics, electronics, media, and computation are hacked and woven, amplified and repurposed. Time is central to material performances, formative processes, and formal (de)compositions.

Since the technologies central to interaction design are relatively new and rapidly evolving, we are only beginning to understand the materials central to practice. Even as such technologies are changing the material conditions for design in general, we must relate to both traditional and contemporary practice of the diverse disciplines involved in interaction design. Our work in the design research program 'IT+Textiles' illustrates one possible approach. Eliciting traces of 'experimental action' from empirical research and the 'workmanship of risk' from craft, 'experimental design' was our conceptual and operational frame for joining diverse materials and domains of practice into shared design discovery and hands-on enquiry. Rough-and-ready techniques and off-the-shelf technical platforms were appropriated into collaborative tinkering with material combinations as well as (inter)active material performances. Such experimentation – and resulting materials and forms – were a basis for further development of applications for fashion, interior, and product design.

Use

As discussed in 'Materials', post-industrial technologies must be materialized so that computational and interactive possibilities may be perceived and acted upon. For example, the design of user interfaces mediates between the complex operations 'inside' and context of use 'outside' a technological object. This task may be seen as a 'representational problem', as encoding possible (inter)actions as metaphors and models in advance of and apart from actual use. In reality, however, the temporal form of computational processes is interwoven with embodied, situated, and social processes of use. Looking to the roots of the term 'interaction' in human communication and social interaction, for example, even ordinary conversation is understood as an ad-hoc co-production, in which silence, turn-taking, and breakdowns contribute to how the form of interaction is built up and sustained through action over time.

As an 'interactional problem', the form of a technological object might be understood as produced both by design and by use. While certain aspects may be apparent from the start, others become available as a user interrupts and redirects computational processes. Even spatial form evolves – for example, as the appearance of an interface changes as a user acts upon it. Much of the spatial and temporal form of technological objects unfolds in use – dependant upon whether and how users encounter and reinterpret courses of action through the object. Beyond an all-purpose choice to consume or even ongoing commitment to use, interaction involves participation in spatial and temporal formation. Form is co-produced by design and use, maintained throughout sequences of interaction, and sustained by repeat encounters – even incorporated into embodied experience and cultural practice over time.

Recap

Related concepts are present in architecture. Originally applied to locally-evolved linguistic forms, 'vernacular' architecture refers to forms that are not so much a direct product of design but that are inextricable from (sub)cultural practices. Since architecture is particularly resistant to time, conventions of and change in use take on cultural significance. For example, celebration of the 'ugly or ordinary' gives primacy to popular phenomena over timeless archetypes. In contrast, 'typology' extracts ideal forms, those that persist in everyday habit and cultural memory despite turnover in use and users. Or, perhaps the global nature and scale of use implies a 'bigness' that exceeds local vernaculars and outpaces typological evolution. Approaches to cultures of use are thus reflected in relations between the 'insides' and 'outsides' of architectural objects – for example, as inscription of rapidly-obsolete popular iconography, imposition of more general historical norms, or planned indeterminacy and half-lives.

Not unlike architecture, technological objects have a 'life' long after design. In line with contemporary thinking, we might consider such things as always 'in the making', rather than as inert and static forms that might analyzed in advance of and apart from practices and cultures of use. To some extent – and at least at initially – form is a matter of design. Indeed, things may be designed to invite or inhibit, open or constrain, expose or hide, aspects on the 'inside' to awareness, interpretation, and action 'outside'. But 'use as participation' entails that we rethink relations between design and use. Interaction design brings such issues to the fore, since 'Becoming users' suggests that the use of technological objects involves committed and ongoing participation in the formation of things which, in turn, shape our own material, behavioral, and societal forms. Design matters, but so does use, which tells in time.

In practice, however, there remain asymmetries between design and use. There is an inherent temporal asymmetry, since things must be created prior to use in order that they might become available to be used at all. With new technologies, in particular, it

is difficult to imagine or predict use of unprecedented products. Further, there is an asymmetry of information, since the interests of existing (and future) stakeholders may only be more or less known and involved. Certainly, there are ways to improve such information, for example through design methods, user research, and user-centered design. However, if design only develops to better address asymmetries, the scope of design may be reduced to what can be predicted and known – when, in fact, uncertainty as to future use and eventual users can never be fully resolved.

Indeed, we might rethink 'users' altogether. For one thing, while the term is rooted in industrial and corporate history, much product development in post-industrial society takes place outside industry – for example, as a more participatory culture of user innovation in communities of practice, evading professional categories and even primary market exchange. As mere 'users', people are only referenced to products, downstream of information and decisions about use determined in design. Secondly, 'use as participation' emphasizes formative aspects of product interaction – indeed, many innovations have been the result of improvisation in use over time. Improving design processes and products to better 'fit' use and users might reduce the scope for local adaptation and (sub)cultural appropriation. If use is restricted to what can be preconceived or predicted in design, much of the meaningful and inventive activity in actual (mis-)use might merely be seen as a failure of design.

Recap

Alternatives are explored as 'Participatory practice'. For example, in Participatory Design, 'tactical media', and architecture, things may be designed (or hacked) to be more open to participation. Instead of traditionally closed processees or proprietary products, low-tech, open-source, and modular materials make 'construction work' more accessible. Hactivism also demonstrates how resistant or private systems may catalyze significant participation and inventive use. While much emphasis has been on lowering the threshold of skill and expertise needed to design, participation is not only a matter of 'ease of use', but of seeing how people step up and take over – which may be evident only in the form of material and social interactions generated over time. Indeed, tactical media and architecture often depend upon a critical mass of ongoing participation. In the long term – outside design processes and after design projects end – participation must be taken up and sustained in use.

This discussion exposes more complex relations among people and the production of social and material constructs – rather than polemics of 'leave it to the experts' versus 'power to the people'. Further questions are opened as to how, when, and why power – and consequent risk and accountability – is handed over or taken up. As distinctions between design and use blur – or are broken down through consensus or activism – issues of authorship and accountability may become likewise diffused. With increasing overlap between 'those who design' and 'those who use', we must also reconsider responsibility and criticality, for example as practitioners begin to define new roles, such as 'architect-activists' and 'artist-mediators'.

Perhaps there is an important role for design, as a whole, to construct 'room for doubt', rather than merely resolving or better-fitting product – and power – relations between design and use. Asking 'why', rather than merely answering questions of 'how', with respect to design and technology development, we developed a series of tactics and interventions in 'Public Play Spaces', based on methods informed by art and activism. As a basis for 'suspension of disbelief', 'play' supported imagination about alternatives to the status quo and engagement in embodied and collective action – with the ambition that participants and the public might become 'players', rather than mere 'users', in our design processes and products.

Change

Design is about change – the transformation of raw materials into useful things, competing ideas into persuasive forms, present situations into future reality. Since its effects lie in the future, design must reach beyond accommodation of immediate needs or solutions to present-day problems. As persuasive design and the sociology of technology reveal, design is a powerful force not only in imagining 'what might be' – but determining 'what should be'. Inevitably ideological, design ideas are inscribed into the form of things that enable and disable activities and behaviors, becoming naturalized into lived experience and normalized into cultural practice. Indeed, since technological objects involve the design of temporal form and the form of interaction, design extends to an even greater and more lasting extent into future use. 'Design effects', thus, involve another aspect of time, that of 'futurity'.

While 'newness', 'innovation', and 'progress' are part of the rhetoric of design and technology, counterparts of 'unpredictability', 'disorder', or 'indeterminacy' are often less welcome. However, the future is unpredictable – indeed, 'futurity' might seem the proper domain of economics or politics. Indeed, given the concern of interaction design for future use, one response might be increased emphasis on theories for analyzing and predicting use and users, in order to improve the 'ideological transfer' from design into use. Another response might be more control over circumstances of use and actions of users. Indeed, architecture is quite literally a 'disciplinary' practice, extending ideology into society through spatial forms, and respective 'temporal regimes', that order perception, movement, and behavior. Such responses to the problem of future use might easily, however, cross the line from anticipation to coercion – as in myths of 'total design' providing complete resolution or, in more sinister terms, a total solution, to present differences and future eventualities.

Recap

Indeed, unfortunate effects of modernism's universalizing tendencies spurred an explosion of counter-movements in the 1960s. Contesting design determination of the forms – and norms – of society, proponents of 'total involvement', rather than 'total design', built 'open-ends' into processes and products to accomodate 'active critical participation'. For example, 'anti-design'-ers under- or over-designed things to spark action and protest in use; 'Non-Plan' removed, rather than made, urban plans to provoke a new order from the bottom up, and; 'post-functionalism' broke conventions of design and inhabitation by interfering with perceptual and practical experience. Drawing attention to how ideas might too easily be naturalized into habit or normalized into culture, ambiguous, absent, or disruptive forms evade easy assimilation. Exploiting the power of design, proponents challenged the institutions and ideologies on behalf of which such power might be extended, refusing a merely service role for design practice or a purely instrumental value of design objects.

To the extent that design extends the ideas of its commissioners and ideals of its makers into use, it is engaged in a sort of 'ideological transfer'. Even when pursued as mere 'tech transfer', the design of technological objects must engage in a realm of ideas about design and use, as well as applying materials that in themselves are far from neutral. Understanding that design and technology, our bodies and culture, are part of the field on which ideological and power relations are played out implies the need for further consideration of the role and responsibility of design. Just as design does not involve any absolute determination or unequivocal translation of ideas into form, nor does use merely involve efficient translation of and compliance to such ideas. However, instead of 'total design' or 'waiting for the revolution', perhaps we might establish another basis for reflecting on future effects. Indeed, if there is anything beyond the scope of the design act and imagination, it is 'futurity'.

Given the power of design to effect change – and the particular concern of interaction design for the temporal form and form of interaction in future use – we might look to further develop an ideological and intellectual basis for 'Critical practice'. While art, craft, and architecture have long critical traditions, relatively new fields such as industrial, product, – and interaction – design, are closely bound to recent developments in technology and consumption, with consequent difficulty in locating an established or independent basis for criticality. In architecture, a vivid debate in discourse and practice decades ago carved out certain parameters for enquiry and accountability within the discipline and within the profession. Distinctions were made between the interests of history, theory, and practice, to root respective concerns and establish a basis proper to each for relating to 'critical theories' shaping thinking and practice in the humanities and sciences.

Certainly, ideological reflexivity about the social construction of knowledge, method, and practice has begun to inflect critical technical practice and 'reflective practice' in (interaction) design research. But is not enough to conclude that design and technology are socially constructed without a conception about how alternative constructions might matter and what they might be like. The challenge is not only to relate to the effects of design and technology in terms of critical theories introduced from without, but in terms of operation within – and by means of – practice.

Recap

Indeed, there are various contemporary tendencies representing a growing critique – not only of design but *as* design. Amended as 'conceptual', 'concept', or 'critical', design is countering conventions of utility and efficiency, profit and taste. Within existing systems of capital and culture, challenges are posed to the terms and modes of production, as well as ideas and agency involved in consumption. Some return to the maker-, rather than market-, led logics of crafts, or to art and the media as alternative forums for 'ideological production'. Others draw on the fads and (science) fictions of pop culture and corporate marketing, but to different ends than service to culture or capital. Traversing (and transgressing) domains allows competing values to be played off one another. Rather than 'in service' to problems and ideas determined in advance and outside, design form, craft, and strategy are employed for 'problem-finding' – rather than 'problem-solving' – within disciplinary and societal discourse.

The potential of 'criticism from within' design is in moving beyond hermeneutic practices of analysis and interpretation to crafting tangible critiques and persuasive counterproposals. Form occupies a powerful place in critical practice – to cast new attention on the status quo, materialize alternative constructions, or project visions of the future. Additionally, in 'problem-finding' and materializing alternatives, critical practice might also extend a critique to users and into future use. For example, the 'difficult forms' of critical design might force a different 'reading' of form, and post-critical proponents might expose ethical and moral constructs in ordinary experience – and new forms of reflective (inter)action might emerge and evolve in use over time. Further, critical problems and opportunities arise as (post-)critical designs meet critical subjects in ongoing interactions within personal and public life.

Further, in interaction design, temporal form and the form of interaction might situate and stage new opportunities for 'active critical participation' in more large-scale and long-term change. Touching on such issues in the 'Static!' design research program, we sought to move beyond conventional dialectics of on/off or consume/conserve in sustainability discourse, by materializing energy use in everyday life. Conceptual and concept design were a basis for exposing values and choices embedded in the use of things, and ongoing interaction extrapolated personal choice into reflection on household effects – and on societal change.

Recap

Materials	Use	Change
How do materials affect or mediate relations to our everyday and intimate things that are being transformed by the increasing ubiquity of technology?	*How or when to separate 'design materials' from 'materials for design' in participatory processes?*	*How does 'temporal form' and 'use as participation' effect change in behavior? Processes of assimilation or domestication?*
How are material expressions determined by nature, design, and use? Design by nature? By use?	*At what points and to what extent might participatory methods need to be introduced in order to really effect a participatory process or product?*	*How do attention, action and interaction relate when it comes to designing for reflection?*
How – or whether – to distinguish between the natural temporality intrinsic to any material and temporal form given by design?	*When to focus on collective understanding and dynamics, and when to develop external connections?*	*How does 'critical practice' condition use?*
Any material inevitably displays aspects of its own state and, to some extent, its history and local surround – are (inter)active materials that 'perform' as displays and interfaces different? How? Why?	*How does the complexity of new technologies, and associated specialization, affect issues of accessibility and expertise in practice?*	*Do 'critical designs' produce more than ordinarily critical subjects? Critical of what?*
How to consider material expressions and temporal form together with the evolution of subjective meanings and cultural values in use?	*How to decide the parameters of 'just enough prototyping' in multi-disciplinary projects, in which multiple practices, priorities, and values might conflict?*	*How might objects, or systems of objects, situate connectivity between local action and large-scale or long-term effects?*
In relating, but not belonging, to, materials science or crafts practice, which methods and concepts might be borrowed or combined?	*How might decisions – and the ideologies and values of a particular technology and a design team – be exposed or made apparent to use?*	*Do critical designs remain critical over long-term use? How might assimilation – or domestication – affect resistance over time?*
How to balance the role of design materials and formal representations, design methods and documentation, alongside a more basic need to 'work into' and understand materials in and of themselves?	*On what basis are public and private aspects of use negotiated, managed, and developed?*	*How to consider the role of craft and culture in the context of 'ideological production'?*
How might the degree of control over materials or scale of design work affect different outcomes?	*How to combine or trade off between accessibility and usability or challenge and discovery in use?*	*How might objects need to be crafted differently in order to effect different types of consumption?*
Is tinkering and hacking a form of (re-)production or materials research in itself?	*How to design for critical mass and cultural practices before artifacts are available to be used?*	*Do – or should – such products 'speak for themselves'?*
How to qualify the 'products' of design research? 'Prototype' or 'product', 'example' or 'illustration', 'model' or 'prop'?	*How might the quality and sustainability of meaningful interactions be understood? And designed for?*	*How – or should – a critical design be altered in order to operate in a commercial, artistic, media or other context?*
	How does the design of identity and packaging resist service to a particular ideology, but operate between or across points of view or possible futures?	*How to relate to differences in ideology and criticality among the stakeholders and 'consumers' of design research?*
		How do specific ethical, moral, or political interests situate 'critical practice'?
		Is there a need to be more precise about differences between technical, aesthetic, and political concerns within a notion of 'critical practice'?

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